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THE CIVIL ENGINEERS' CONFERENCE.

THE mechanical engineering papers read at this Conference were very varied, but many were hardly up to the standard we should have expected on such an occasion. One by Mr. B. Donkin dealt with the question of steam production and economical working, but failed to rise above the level of a *resumé* of recent practice or a succession of platitudes. Thus we are told that deposits of soot and lime are both bad conductors of heat, and that facility for repairs is very important, especially in water-tube boilers at sea. We might just as well be told that a 12-foot hole through the bottom of a ship is not conducive to safety. Mr. Donkin referred also to the use of powdered coal for boiler firing as now used on the Continent. There would have been some good in this if he had told us what means, if any, had been adopted to prevent the dust when burned to its ash from escaping at the chimney top, or settling in the boiler flues. One of these undesirable results is bound to follow as a matter of course. The sprinkling mechanical stoker using ordinary slack coal brings about both the above results, and it is folly to blink the fact as regards dust fuel fired right in the airway. As Mr. Donkin acted as wet nurse to the dust firing furnace when introduced in England, he ought to be able to make a plain statement. In discussing Mr. Donkin's paper, Mr. M. Longridge summarised the question of cylinder condensation by pointing out the need for definite information as to the true relations between piston speed and cylinder condensation, and he called for greater attention to the sloping of steam pipes towards the engine with ample provision for drainage.

Mr. Barry suggested that dust firing might perhaps be worth reviving, but he did not suggest how this could be done in a satisfactory manner. Capt. Sankey was responsible for the statement that in Alsace steam was used so hot that when the engine stopped it was necessary to keep a current of steam flowing through the cylinder to prevent it from cracking. It would surely be better practice to cut off the superheat a sufficient time before stopping to allow the cylinder to part with its excessive temperature, especially as there must be special pipes and valves arranged to allow steam to flow through a standing engine. Sir F. Bramwell said he never could see the use of feed water heaters with properly proportioned boilers. This is a very funny way of stating matters. Surely any boiler that is, especially at present day pressures, large enough to do without a feed heater, is too large, and better practice would be to use a smaller boiler, and supply it with water heated in a separate vessel. We wonder how Sir Frederick would proportion and work a boiler at 165 lbs. pressure (corresponding to a temperature of 358°) in order to get the chimney temperature to the figure he named—350°, or even to 450°.

Mr. Davey's paper on separate condensing plants was a better contribution, because it stated facts not yet sufficiently known. Mr. Davey, when designing cooling ponds, has given $2\frac{1}{2}$ square feet of area, and $12\frac{1}{2}$ cubic feet of water for

each pound of steam to be condensed per hour. In evaporative condensers he gives 1 to 1½ lb. of condensing water for each pound of steam, and a minimum of 1 square foot of cooling surface per 10 lbs. of steam to be condensed. These figures are for Messrs. D. Stewart & Co.'s condenser, which includes also a supplementary condenser, through which passes the water on its way to the main condenser, and the residue of the vapour from the evaporative condenser. This auxiliary condenser need have only 1 foot area to 55 lbs. of steam, and the circulation of water should be 20 times the weight of steam to be condensed.

Mr. Robinson thought, very properly, too, that condensers should be close to their engines, and Mr. Tannett agreed, whilst Mr. Longridge condemned the use of one condenser for several engines for this same reason of long distance, which is not only pernicious in itself, but introduces the risk of much inlet of air. He also considered that about 3 lbs. of condensing water was enough to condense 4 lbs. of steam with a suitably proportioned condenser, although this resolved itself into a question of more metal or more water, whichever might be the cheaper. In any case it is best to cool the condensing water and use the same over and over again.

A paper very appreciative of Holden's liquid fuel system for locomotives was presented by Mr. Aspinall. So far as Mr. Aspinall's own experience goes with Lancashire coal at 9s. per ton, the cost of liquid fuel should not exceed 1d. per gallon in order to do equivalent duty. In the South, with dearer fuel, the competition of liquid fuel becomes easier. Experience on the G.E.R. shows that where a locomotive would use 35 lbs. of coal per mile, it will use 11·8 lbs. of coal and 10·5 lbs. of oil, or 16½ lbs. of oil if no coal be used. Up to recently this railway used Astatki at a sp. gr. of ·906 igniting at 336° F. At present, owing to the small amount of this refuse coming to the country, green oil from the gas works is used. This has sp. gr. of 1·1 and a flashing point of 220°. Mr. Bell, who is Mr. Holden's assistant, and with whom we once had the pleasure of a ride to Cambridge on the "Petrolia," stated that 650 gallons of oil, enough to run 500 miles, could be run into the tender in two minutes. The copper fire boxes lasted better than with coal, and the blast nozzle could be 30 to 40 per cent. larger. Mr. Paxman had something to say of the noise of burning oil—a quality that is certainly not noticeable on the G.E. engines, and also of the danger of gas explosion in the fire box, a notion Mr. Holden characterised as chimerical. He stated that last year he had burned 5,000 tons of liquid on his railway. It seems to us that there is no question whatever of the success of oil fuel from what we have seen of it on the G.E.R. The sole question is one of supply of the liquid.

We need not say much on Mr. Pain's paper on light railway location, further than that the surface line or contour line was advocated as the most economical. This is what Locke advocated in the early days of railroads, as against the Stephensons' policy of direct routes and no curves, but plenty of heavy works. The Stephensons may have had faith in the locomotive, but, like Cromwell, they followed the adage of keeping dry their powder by finding as level a road as possible for their engine to travel upon. The roads of the country are by no means laid out to suit light railroads, so Mr. Pain would leave the roads and build his light railroads more in accordance with correct alignment. Very correctly he would limit speed to 12 or 15 miles per hour, and when so worked, as we have always held light railways should be worked, the expense of signals, except to a very limited extent, disappears, and there is no need for cattlepens, ramps, long or high platforms, and many other costly items of ordinary railroad equipment. The views put forward were combated in discussion with all the stock arguments, and we seem no nearer finality on the gauge question than in the days when Brunel was trying to introduce his 7-feet gauge.

So far as breadth of gauge is concerned, we do not see much in the maintenance of the standard gauge for light lines, if only a rigid limit of weight could be adhered to. This could be arranged by the use of small locomotives and low speeds. We have already often cited the light line out of Wisbech, where ordinary trucks were hauled in a short mixed train by a mere tramway engine made at Loughborough.

Mr. Parsons, of steam turbine fame, described the *Turbinia* torpedo boat, which is driven by his engine or steam turbine. As the speed attained was 32¾ knots with 2,100 I.H.P., and the engines only weigh 73 cwts., the total machinery weighing, with water, 22 tons, it appears that nearly 100 H.P. is developed from each ton of machinery, and nearly 50 H.P. per ton of displacement. The *Turbinia* is 100 feet long, 9 feet beam, 3 feet draught, and 44½ tons displacement. There are three screw shafts, each with a compound turbine of parallel flow type, with steam of 170 lbs. expanded to 1 lb. condensing pressure. On each shaft are three screws, making nine in all. They have a diameter of 18 inches, and run at 2,200 revolutions. They are placed under the sternwards quarter length of the vessel, the bottom of which is sloped up towards the stern to allow of them. The deepest screw only extends its tip about 18 inches below the midship draught. Mr. Froude considered that, if it were possible to gear down, an ordinary screw would give better results. Sir W. White pointed out the difficulty of reversing, but Mr. Parsons said that with an additional weight of ¾ ton he could add a reverser which would give 12 knots astern. We would like to ask how comes it that the author talks of the I.H.P. of a steam turbine? How does he *indicate* this?

We omit for the present any reference to Mr. Seaton's paper on the water-tube boiler, as we intend to refer to this more fully than present space allows, and pass on to Mr. Dowson's paper on gas for power purposes.

Mr. Dowson has done so much for this branch, that one regrets he has not kept pace with the times in the mechanical arrangements. We have seen Dowson plant that has been almost enough to condemn the system at sight, and thought what a pity it was to endanger a principle by so neglectful practice.

As a basis of comparison, it was stated that for powers of 30 H.P. or more, anything over 3s. per 1,000 cubic feet for town gas makes the cost of gas power greater than steam power. Good engines, however, driven with producer gas, only burn 1 lb. of fuel as against 2 to 3 lbs. for steam engines, and an engine of 120 I.H.P. has run five hours on ¾ lb. of fuel per I.H.P. hour. Mr. Dowson made some reference to the possibility of using bituminous coal in gas producers for power purposes, as though this had not been done, but only approached by Dr. Mond on a very large scale. Surely Mr.

Dowson must know that the Thwaite plant worked continuously with bituminous fuel, and was fully described both in our own and the columns of other journals. There was no trouble with tar, and a sawdust filter removed any trace of dust.

Mr. Swinburne presented a paper upon the spring mounting of generating plant to nullify vibration. One thing is certain, that with all practicable engines there is either vertical or horizontal movement. Given a good floor, and engines may be fully balanced horizontally; but the question of balance resolves itself largely into a question of dry or wet base, or lateral continuity. A thick bed of shavings under a concrete bed, and a layer on all of its walls has been found to prevent vibration, and the present writer has advised perfect vertical balance and suspension of the whole engine and bed by long rods, with freedom to swing laterally as a means of checking vibration. As a fact the balance of an engine requires to be suited to the conditions of the particular engine. It depends upon the nature of the floor and for foundations very much upon their dryness. A wet bottom under a large block of concrete may give rise to very bad vibration, for it causes lateral communication of the vibration, and such a case would be better met by complete vertical balance on a block entirely free laterally from any connection with other structures on the ground. The discussion elicited was not of much value.

The New Guattari Motive Power.

An invention which promises us a saving of 50 per cent. of the fuel consumed by the ordinary steam boiler, certainly deserves the attention of the engineering profession. This remarkable result is claimed to be achieved by adding to the water in a steam boiler a liquid, which we now learn from Mr. Guattari's specification, is a mixture or compound of carbonic acid gas and ethene chloride. Ethene chloride, or, as it is more usually called by English chemists, ethylene chloride, or Dutch liquid, is a brownish liquid which boils at 82°·5 C., giving off a vapour which burns with a green flame, and is explosive. Mr. Guattari appears to consider that this liquid forms a compound with carbonic acid gas, and when water is impregnated with this compound "the generation of pressure is rendered possible with an expenditure of heat energy much less than required with ordinary steam." The carbonic acid gas is generated in the ordinary way in a suitable closed receiver, which is provided with a stoppered mouth by which the Dutch liquid is introduced. The proportions which are found suitable are:—Water 28 litres, whiting 7 kilogrammes, acid 2 litres, ethene chloride 140 grammes. The resulting compound gas passes off through a pipe (provided with a check valve) and is injected into a saturator filled with water. The water saturated with two or three times its own volume of the compound gas is forced by a feed pump into a steam boiler. Here it is evaporated and does work in a steam engine, from the exhaust of which it passes into a surface condenser, wherein condensation takes place without separation of gas. The condensed solution is then forced back by an air pump into a receiver at atmospheric pressure, from whence it is pumped again into the saturator. At first sight, this invention looks like an attempt to get round the second law of thermo-dynamics, but it is not necessary, however, to suppose that Mr. Guattari is engaged in any such quixotic attempt, since there are, about our best steam engines, many unconsidered trifles of wasted energy left for the ingenious inventor to pick up. Still we think 50 per cent. is too much to expect from this source. We shall await with interest the result of properly conducted tests on a plant of suitable size and under the usual conditions of steam utilisation on a moderate scale before we accept the sanguine views of the promoters of this remarkable invention.

A Foreign Invasion.

At a public gathering recently held in Leicester, a speaker referring to the Corporation Electricity Works, said that "when they got the new dynamos from Buda-Pesth, they would have one of the finest installations in the country." The Corporation of Leicester have developed one or two curious features in their public system of electric lighting, and it will now occupy the unique position of being the first municipal body in the United Kingdom to use lighting plant made abroad. Not for one moment do we suppose that the new dynamos from Buda-Pesth will not be of the highest quality, but in face of the fact that of the 130 central stations in this country not more than one is provided with foreign made plant, it is startling to find that there is a possibility of Continental dynamo makers competing with home manufacturers on their own ground. It would be interesting to know whether the Buda-Pesth machines were selected in competition with other tenders, for we take it that a Corporation when undertaking extensions or alterations would be almost compelled to advertise, and we have no knowledge of any public tenders being announced from Leicester. However that may be, it will be generally admitted that the Corporation of Leicester ought to be provided with very good reasons for going beyond English makers for their plant, especially when it is borne in mind that Corporation Electricity Works with home made machinery, have proved themselves to be, not only sound commercial undertakings, but efficient in their working and for the most part easy to manage.

Electric Traction and the New York Elevated Lines.

This title is written advisedly and not off-hand; we can't fairly change it to "Electric Traction *on* the New York Elevated Lines," because at present there is no such thing. However, the prospects of the entire Manhattan system being converted to electric traction are practically settled favourably; and after an interval to date of nearly eleven years since the first experiments in this direction by F. J. Sprague (and later by Leo Daft) it really seems as though the matter were going through with final and complete success. If, by the way, it takes nearly eleven years for the New Yorkers to make up their minds to electric traction on their elevated lines, probably twice or three times that interval will not be too much for old fashioned folk like Britishers to contemplate electric tramways and railways with toleration, not to say approval. Only the other week we heard of a short branch line proposed to be built as a light railway from an important main line junction to a new seaside place about 7 or 8 miles away. Although everything is in favour of an electric service (even with half-hourly or hourly trains), combined with electric lighting at both ends, yet the line is to be worked by steam at a loss or an infinitesimal profit, and will probably be so operated until more go-ahead and progressive people get hold of it, and equip it for electric traction, like the Isle of Man lines. However, this is a digression. To return to the New York elevated lines, it may be noted that in this matter Chicago has fairly led the way on the other side, just as Liverpool has done with us in overhead lines, and London in underground ditto. The essence of their success is shown by the words of Mr. Fransioli—the general manager of the Manhattan Elevated Railways—after his return from inspecting the Chicago lines. He says:—"The Chicago elevated roads using electric traction run four-car trains with 1½-minute headway, which is one-half the headway allowed in New York on Third Avenue. They run at a slightly greater speed than in New York, stopping at stations about the same distance apart, and work at a total expense considerably less than with steam locomotives on the New York lines." Small wonder then that with such powerful facts as these before them, the directors of the Manhattan lines have practically decided to adopt electric traction for their service. There is in reality no serious difference whatever between the working conditions upon the New York Elevated and upon the London Metropolitan and District lines, except that the latter, being in a tunnel, are less fitted for steam working. We suppose, however, that as stated above, it will take at least another 11 years from now to bring the London boards up to the scratch of spending ten shillings to get a sovereign, and adopt electric traction, even at the expense of fresh capital outlay, and wiping off as worthless a good deal of their apparently well moistened (if not actually watered) present stock.

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STORAGE BATTERY TRAMWAYS.

It was perhaps hardly to be expected of the Birmingham Corporation Tramways Committee (accustomed as they must be to seeing a skeleton in the cupboard, in the shape of the unfortunate Bristol Road accumulator worked line) that they should go into raptures over storage battery working as they appear to have done with regard to conduit systems.

For all that, however, there is—at least on the ground of first cost if not of maintenance and working expenses—quite as much to be said in favour of good accumulator systems as of any closed or open conduit yet devised.

The details lately published in regard to the results of working upon the Hanover tramways, are certain to make a great many engineers lift their eyebrows; and so, too, will such facts as the installation of 35 accumulator cars on the Madeleine-Courbevoie line in Paris, running upon three routes with a total length of 11 miles. It was also decided some months ago to equip the Englewood-Chicago line with accumulator cars; and we have waited for some time to get working details of this last-named line in order to publish an account of it.

Of course, there are apparently good reasons in all these cases for the employment of storage battery cars; Paris has always (and perhaps deservedly) expressed antipathy to the overhead wire; though from what we hear this prejudice is likely to give way even there.

The line in Chicago strongly resembles that at Hanover, in so far that in its early stages the storage battery interests have themselves entered financially into the working and management of the system. Apparently, at Hanover, they are contented with the results; whether this will be so or not at Chicago remains to be seen. At any rate, everything there has been so designed, that if storage battery working proves unprofitable, the system can be changed over to trolley wire methods with a minimum of trouble and expense.

Some very excellent particulars of the Chicago line were lately published in the *Street Railway Journal*, and we append a few of the more notable particulars with comments where necessary.

The total street length covered is about 35 miles, the length of track being about half as much again. Rails weighing 80 lbs. per yard are used, with four brace tie plates to each rail and tie rods at the joints. These rails are mounted on transverse sleepers set on 6 inches of gravel, and the whole track is considered heavy and substantial in view of the use of weighty accumulator cars. We should consider such a track to be only light for ordinary trolley cars, weighing from 2 to 3 tons or thereabouts less than accumulator cars!

The power house has quite a number of very good features about it that may be studied with advantage by English engineers. Thus, all the generators are direct coupled to the engines, and the driving shafts are so arranged in hollow sleeves provided with couplings, that any one of the generators may be run from either engine.

There are four 250 kilowatt generators, two 250 H.P. inverted vertical triple expansion Willans engines, and one 500 H.P. ditto with four cylinders. The plant is arranged thus, all in a row:—

Engine (250 H.P.).	Generator (250 kw.).	Generator (250 kw.).	Engine (500 H.P.).	Generator (250 kw.).	Generator (250 kw.).	Engine (250 H.P.).

Amongst other points of interest may be noted the following:—First, the smoke flue from the boilers is mounted high up on horizontal arched girder construction, instead of being half buried in the ground after the fashion more common with us. Then the chimney stack is made of steel plate and is self-supporting, even with a height of 150 feet and a diameter of 7 feet.

Condensation water for the main engines is cooled by means of a steel tower 30 feet high and 12 feet diameter, filled with vitrified sewer pipes placed on end in zigzag fashion, of course, with artificial fan draught upwards.

The switchboard arrangements are at present devised specially for storage battery working. There are three different positive bus bars for the charging current from the generators at 150, 170 and 190 volts; the batteries are switched on to these one after the other during the charge. The generator voltage is also varied by the field regulating switch and resistance, and each machine may then be connected through a three-way switch with any of the bus bars. An automatic full charge indicator is employed to show the attendant when charging is finished.

The car batteries are placed on trays carried by cross bars on the truck, and are not—as more usually happens—put under the car seats. For each car there are 72 cells, in four sets of 18 each. These are connected all in parallel, two in series and two in parallel, or all in series, according to the voltage and speed required.

The type of battery employed (chloride system) is especially designed for high discharge, giving at a two hours' rate about 80 per cent. of the output at a 10 hours' rate.

The Chicago line is apparently not yet at work, so far as latest advices state; but Paris has for some time had its accumulator line to Romainville, and within the past two months or so yet another battery system has been in operation from the Madeleine to Courbevoie and Levallois.

The total length of line on the three routes comprised by the latter system is about 12 miles in all. The power house is situated at Puteaux, on the river bank, and at some distance from the Courbevoie-Neuilly terminus. The station voltage in this case, however, varies from 600 to 660 volts, there being three distributing posts or centres, one at the end of each route. The feeders supplying these distributing or charging centres have diameters respectively of ·233, ·233 and ·387 square inches, according to the distance between power house and feeding points. These distances are respectively $\frac{1}{2}$ mile, $1\frac{1}{4}$ mile, and $2\frac{1}{4}$ miles.

The feeding centres are literally distributing posts, as they consist of cast-iron pillar boxes somewhat resembling fire alarms, but of course larger and more substantial. Connection between them and the cars to be charged is made in each case simply by a flexible cable, but the terminals and plugs are shaped differently for positive and negative, so that no mistake can be made, and the car batteries reversed. An automatic device indicates the completion of charge to the "wattman," as the motorman is called in France.

The car batteries are 200 in number, each cell weighs about 36 lbs. and contains five plates, the Tudor type of element being used.

They are placed under the car seats, arranged in four series of 50, and are always charged and discharged in series, the controller alone being used to regulate the current supply, as in the case of trolley wire lines. Since the cells are charged in position, they do not require moving except at rare intervals, and hence are carefully boxed up almost hermetically to prevent gas or fumes reaching the interior of car.

The cars themselves—35 in number—are double decked, designed to carry 52 passengers, and weigh 14 tons fully loaded. They can also each draw a trail car weighing up to 7 tons.

A two-way double-pole switch is provided for the battery terminals, so that they may be connected up to the motors through the controller, or else to the charging cable terminals at distribution posts, but not to both at the same time. There is therefore no risk of the motors receiving current direct from the feeders. Switches are also provided for operating the battery in separate halves if necessary.

The main controller has a number of contacts for regulating the current and pressure in the usual way. The first throws the two motors into series with a liquid resistance consisting of a lead plate in a bath of carbonate of soda, the depth of immersion and consequent diminution of resistance being regulated by a toothed sector (worked from a gear wheel on the controller spindle) with cord and pulleys. A metallic rheostat replaces the liquid resistance on the third notch; on the fourth the motor fields are partly shunted. In cutting off current the controller handle is moved back, and passing beyond the first notch, winds up the brake chain.

The usual separate reversing switch is provided, and it is also possible by its means to couple the motors in parallel, though why this should be done by the reversing switch, and not by an additional notch on the main controller, we cannot readily see. The same switch also serves to operate an electric brake, the motors presumably acting as generators against the battery, but no particulars are given beyond a

statement that the electric brake is found to be too energetic, and the ordinary hand brake suffices. If this be so in practice, it seems obvious that the running speeds cannot be very great.

Lighting of each car is effected by means of six lamps in series across the battery mains. When charging, two additional lamps are thrown into circuit; and in case of accident to the lamp circuit at any time, a special switch enables the front and rear signal lamps to be fed from 40 cells of the main battery.

Charging goes on every time the cars arrive at terminal posts, the average current being 120 amperes for 10 or 12 minutes. Two small fan motors are used at the same time to draw out the gases and fumes from the battery chambers under the seats.

RAPID CABLE LAYING FOR WAR PURPOSES.

In the Electrical Review of May 14th, 21st and 28th, will be found a reprint of a paper read before the "Royal United Service Institution" last April, on a system of "Rapid Cable Laying for War Purposes," by Lieutenant Crutchley and Mr. C. Scott Snell.

In the words of its authors, "the object of the paper is to elicit an opinion whether in future operations it will be to the advantage of a naval commander-in-chief to have at his disposal the means of establishing communication with either a base or outlying picket of ships at a moderate distance—say 300 to 500 miles; and whether the fact of his being able to establish such a communication at the fastest speed yet attained by a war ship may not be of material value in working out a combination of effective force."

We may be content to accept this postulate on the authority of "The Navy and the Nation," when it says "an organised system of coast observation and intelligence is absolutely necessary to a defending fleet if it is to secure the full advantages of that superiority of force which is England's prerogative at sea;" for apart from all questions as to the uses to which cables can be put in time of war, there can be little doubt that it would frequently happen, as has been the case before, that "the first thing an enemy would do would be to cut cable communication, so that the sooner it can be restored the better." This may readily be conceded, so that any suggestions which promise an improvement in the present rather slow system of cable laying should be cordially welcomed as an advance in this most important branch of engineering.

Moreover, as the authors truly remark, "there is the great and incalculable boon of being able to lay at full speed a cable where none is shown to exist, and which consequently would not be searched for by the enemy.

It is evident that the authors have devoted much time and thought in developing their ideas, and they have evolved a system which differs in almost every respect from that which has remained practically unchanged since the first Atlantic cable was laid.

It is claimed that "the plan which is here adopted, though not by any means perfect in detail, yet gives a workable scheme which should render this object a matter of comparatively easy accomplishment."

The important questions to be kept in view while considering the scheme seem to be:—

Firstly: Is it workable, or capable of being made so?

Secondly: Would the increased speed of laying promised make up for any additional expense or risk entailed?

Even if judged incapable of attaining the very high speed anticipated by its inventors, possibly a reduced speed, exceeding that of the present system, might be sufficiently important to justify its employment. The method of communication through the cable when laid is an altogether separate consideration, as that would apply to any cable, irrespective of the speed or manner of laying.

To assist in forming a comparison of methods, we may mention that 8 knots an hour is considered a rather high speed to pay out even "deep sea" cable, though there have been occasions when, under very favourable conditions, 10 knots have been accomplished. So high a speed, however, as 10 knots is considered dangerous, even with very large tanks, and the ship would be slowed down while the cable near to the cone is running out. Were it not for this fact, cable could be laid much faster, for although a long drag from the tank and the heavy break drum may prevent the cable running out fast enough to provide for sufficient *slack* when laying over an uneven bottom, this might easily be obviated, and the drum assisted round by a motor or steam-power. This expedient would provide means of laying cable as slack as required, even in shoal water, and at a speed considerably over 10 knots an hour; but as before mentioned, the risk of turns fouling in the tank prevents this.

We will now refer more particularly to some of the details of the machinery devised by Lieut. Crutchley and Mr. Scott Snell.

Main Rotating Drum.—A monster drum, weighing 180 tons when full of cable, and revolving at 45 revolutions per minute when full, and 100 revolutions when nearly empty, should not be introduced into the limited space of a ship if it can be avoided, even though it be under the most perfect control; for accidents may happen which would imperil the ship's safety. Although, from a mechanical point of view, we do not question its practicability, we are inclined to prefer the *small unit system*, or fixed drums each holding 40 knots of cable, both on the ground of safety to life, and also to the cable. The reason for this will be explained when dealing with the *accumulator*.

Small Unit System.—Notwithstanding our preference for it, the fixed drum method does not appear to be free from weak points. For instance, the first sudden starting of the rotating arm by the cable, when changing drums, would make it move round quickly, and loosen the band brake more perhaps than at any other time, and turns would probably be slackened, and allow the loose top turns to spring out and fall over others, so as to prevent the cable running out freely. Placing the counterpoise weight, as proposed, near to the centre of rotation *at starting* would, moreover, tend to increase the rate at which the arm commences to swing round from the state of rest. The action of the overhead guide wheel is not very clear, and although it is mounted to swivel automatically when the last turn of cable has run off a drum, it appears a likely source of danger; nor is it very evident that the cable would, without fail, clear the vertical guide wheel on the arm when the bight passes from an empty drum to the next full one.

It certainly looks dangerous, as the cable would be under tension all the time, and, from the momentum acquired, the arm would be likely to follow the bight round for some distance, notwithstanding the brake. Then, again:—It would be impossible to regulate this brake after the cable had once started running off the drum.

The tug of the cable, when changing from one overhead guide wheel to the other, would be very violent, notwithstanding a certain slowing down of the accumulator *receiving* drum, and one would expect it to damage the wheel, if not the cable also. Altogether, this operation seems rather risky.

It would be interesting to have an illustration of the *automatic mechanism* inside the main tank for insuring regularity in laying each convolution of cable as received on board; and also to know the speed per hour of coiling. In large cable tanks, coiling down in the usual manner may be taken as 5 knots an hour for the maximum speed.

Accumulator.—The principle of the accumulator is decidedly ingenious as a method of preventing an abnormal strain from outside the ship injuring the cable. This accumulator forms the most important part of the machinery in either the stationary or rotatory drum methods.

When working with the *main rotating drum*, should the *receiving* drum be running short of cable owing to its receiving less than that passing off the *delivery* drum, increasing the speed of the receiving drum would apparently put some strain on the *main* drum. No doubt this strain would, to a certain extent, accelerate the speed of the latter, but owing to its inertia it would possibly not respond sufficiently quickly, and the cable would very likely be strained, if it did not break. If, on the other hand, the speed of the main drum be first increased, what is to prevent kinks?

Again:—When the accumulator is full, there is the possibility of the supply from the main drum being too great for the accumulator receiving drum to take up the slack, and the springy steel cable may get loose on the drum, causing

turns to ride, even if kinks do not occur. It is said that "the very loosening of the amount of this 'bight' can be made to increase the supply of steam, or other power, to the main paying-out engine, and it is only the delay in the responsiveness of such engine and its load that has to be provided for." It is also stated, when speaking of the "tangent sheave" on the accumulator, that "any movement of the torsion producing motion typified by the weight, W, will be the signal for the engine driver of the main rotating drum to re-adjust the engine speed so as to keep the drums adequately supplied with cable. This might be automatically effected *if wished*, but might increase risk." An automatic method certainly seems necessary to meet possible dangers referred to above, and it is partly owing to them that we incline less to the *main rotating drum* system than to the alternative method of *unit drums* fixed in columns, especially as stoppage can much more quickly be effected by the latter method. There is also the important consideration that a very much greater length can be laid continuously, whereas a splice would be necessary if more than one *rotating* drum had to be used.

Stern Pulley or "*Ejector*."—There would probably be very considerable *slip* with only two or three turns of bright steel cable around the ejecting drum. Some provision in the way of a guard abaft the ejector is required to prevent the cable being forced up when the ship's stern sinks during heavy pitching, but this is a small detail.

Cutting the Cable.—The means provided for cutting the cable are simple and likely to be effectual, since the power forcing the sharp chisel and anvil forward as the two wheels turn would be very great.

Buoying.—Buoying a bight of cable in shoal water by letting the ship pass between two other ships or buoys, connecting which a steel hawser is laid, is certainly simple and free from objection, but in the absence of details the other methods of buoying at full speed, as illustrated on page 725, are not easily followed.

Patent Log.—Objection has been raised with regard to the use of the "Patent Log" for indicating distance over the ground, but on considering the point this does not appear to offer any serious difficulty in the case of an "emergency" cable, as sufficient margin of safety may be allowed by the officer-in-charge, according to local currents, or whether the vessel is running with or against the tide. Besides, there is no reason why the more reliable plan of paying out fine steel wire under tension, and allowing the drum from which this wire runs out to indicate the distance over the ground should not be adopted. The worst objection perhaps to the Patent Log is its liability to get foul of seaweed or anything floating in the water.

Electrical Controlling Instrument.—It is explained that the driver of the ejector has the speed to which he must work indicated on his standard instrument which is regulated by another instrument under the control of the officer-in-charge; but it is not explained what guides the attendant of the accumulator engine. It is presumed that as the ejector driver is within easy hail, any change of speed is passed by word of mouth. It is presumed, also, since an automatic adjustment of the main drum speed is not recommended, that when the accumulator is becoming depleted, or the supply of cable tending to be excessive, the attendant is expected to communicate the fact by speaking tube, or other means of signalling, to the driver of the main rotating drum.

Testing the Cable.—No reference is made to testing and speaking through the cable while laying it, but this should present no difficulty if the so-called "small unit system" be adopted. Nor, indeed, would speaking and testing be impracticable if the cable were paid out by the large revolving drum method. In this case the first end, when coiling the cable on board, might be led through a hole in the broad end of the axle to a copper projection on the extreme end (insulated by ebonite from the frame of the drum), against the surface of which spring contacts can be made to press in a way similar to contact brushes on the commutator of a dynamo.

Such springs would be quite satisfactory for the usual methods of speaking, and if kept clean, for a rough insulation test also. Under the special circumstances of laying cable at a time when speed is all-important, it is presumed that it would not be desirable to stop the ship and pick up to a fault; and, providing that speaking through the cable be practicable, the ship would in all probability complete the laying, leaving the weak place to be cut out when a favourable opportunity offered. If, on the other hand, the cable gets so damaged by an accident that speaking through it becomes impossible, the fact will be known, and there will probably be no occasion to localise the fault. If required to do so, there will be no difficulty, as the ship will have stopped paying out, and the testing lead can be screwed firmly on to the copper boss, instead of testing through the spring contacts.

Speaking through the Submerged Cable.—Not satisfied with having elaborated a system for increasing the speed of cable laying, the authors—who are evidently thorough "Progressives"—next take an excursion into the field of speculation, and hurry along, rather faster, perhaps, than our older limbs can follow, to show how experimental results have of late years proved the practicability of a ship stationed at one point over the line of a laid cable communicating with another ship riding also over the line of cable, but possibly 200 or 300 knots distant, through the medium of the cable conductor, by purely inductive influence.

It will be evident that the subject is quite distinct from the question of rapid cable laying, but any such system of signalling which in course of time is proved to be practicable would certainly add very greatly to the use of submarine telegraphy for war purposes, so that all attempts in this direction are worthy of serious consideration.

While we do not wish to commit ourselves to what we think is a rather sanguine expectation, yet the idea does not seem by any means impossible, for the progress made in speaking by induction has lately been so astonishing that we are quite prepared to hear of telegraphy even under the conditions referred to made practicable. Indeed we are already aware that under certain conditions, more limited in scope no doubt than those contemplated by the authors, signalling by induction has succeeded. The uncertainty as to the precise position of the cable in deep water, especially in a fog when "the time saved and service rendered would be all important," would be the chief trouble, considering that inductive influence is very greatly weakened by distance. Then the exceedingly high KR of so long a cable would greatly increase the difficulty, but with alternating currents, and such a remarkably sensitive receiver as the telephone, it does not seem beyond the bounds of reason to expect to detect signals passing along a cable, even of the length mentioned, by means of the induction set up in a neighbouring parallel circuit. *Speaking* would, of course, be out of the question, but it is probable that strong alternating currents of high frequency would produce through such a cable an audible sound in a telephone, and this being so, the pitch of the sound might be increased by a higher frequency to produce a sound distinct from the first, so that a combination of these two sounds would produce intelligible signals in the manner of the Bright's bells. There is no doubt that such signals would be efficient for a very long length of cable. The most promising of the methods hitherto suggested would probably be trailing a long length of telegraph cable [the lower portion *unsheathed* but suitably strengthened and protected from abrasion] from the stern of the ship very slowly over the bottom along the line of cable and in the most favourable position indicated by soundings. The distant conductor end of the trailed cable should have a large metallic surface exposed to the water, and the *earth* to complete the circuit may be obtained from the ship's hull.

How one ship would "call up" the other would be another difficulty which could probably only be met by regular *watches* being kept on board, unless efforts to devise an efficient telephone relay should succeed in meeting the difficulty.

Such a system of signalling may reasonably be considered too uncertain for the important object it is required to serve; but we are here only discussing its practicability, and if the methods of signalling suggested do not commend themselves to electricians as satisfactory, there is no reason why the cable should not be worked, at any rate, by the usual methods from terminal stations.

The instance given of bridging an interval, even 870 yards long, without wires by means of coils of very large diameter acting on each other inductively is, no doubt, possible, but it does not bear directly on the altogether different conditions of a *straight* cable; nor does the successful experiment instanced by Prof. Blake, when signalling between the shore

and a light-ship only 6 miles distant, appear relevant, except in the case of a short cable between scouts cruising off the port blockaded and the main blockading force some few miles off, where Prof. Blake's very different method of signalling would, no doubt, be applicable.

We may say in conclusion that the opinion we have formed of the methods of cable laying is that the additional engines and brakes without doubt make the system much more complicated than the present method; but that does not mean that it could not be worked successfully. We consider the fixed drum system the more simple and promising scheme to adopt in many ways, more especially as the cable is much more under control, and can be stopped running out very much more quickly than were the main rotating drum employed. In fact, this drum seems to us the chief source of danger, and without it the system becomes comparatively simple. It seems a bold, but by no means an impracticable scheme. An objection which we before raised as to the difficulty of getting sufficient *slack*, when running at such a high speed, has been removed by means of the "Ejector," which is an important improvement since we considered the system last year.

The question is a very interesting one, and we shall be glad to hear that a paper dealing fully with the subject is to be read at the "Institution of Electrical Engineers," so that it may receive the valuable criticism on technical points which a discussion by cable experts will be sure to draw forth, and several points at present rather obscure might be elucidated by the authors.

ACCIDENTS WITH WIRES—THEIR CAUSE.*

By W. S. ECKERT.

Apropos of the article appearing in the May 12 issue of the *Electrical Engineer* on "Accidents With Wires," it seems to the writer that there ought to be some way of reducing the number of accidents there recorded.

It has been shown that hard drawn copper wire, having 98 per cent. of the conductivity of pure copper, lacks tensile strength and absolute reliability from a mechanical point of view. Not only does such wire stretch under its own weight, the diameter decreasing always and with it, also, its mechanical resistance, but the slightest abrasion, caused in transportation or when putting the wire in place, will bring about complete rupture when the wire is subjected to strain. The one important mechanical advantage of copper is that it does not corrode.

Galvanised iron wire and steel wire rust, and, as the points of oxidation increase the mechanical resistance decreases. These wires, when first put into service, are, as compared with copper, but poor conductors, but, when oxidised, they lose a large part of their initial properties. It has been found by experience that neither iron nor steel wires can be relied upon, either electrically or mechanically, for any considerable time; they are, therefore, really more costly than a high-grade conductor in the end.

Bi-metallic wire, composed of copper and steel—steel centre with solid copper surrounding it—seems to meet the mechanical deficiencies in copper wire, though, for the transmission of direct currents, at the expense of conductivity. In view of the many accidents caused by the breaking of wires, and the liability of damages therefor by the operating companies, it is a question whether it is not best to sacrifice a certain portion of the conducting qualities of the wire rather than the strength. Bi-metallic wire, like copper, does not corrode, neither does it stretch. It retains its electrical and mechanical qualities always, as shown by the experience of the Postal Telegraph Cable Company with wire of that description, put up in 1883, and which, according to reports of the officers of that company, tests as well to-day as it did fourteen years ago.

The conductivity of bi-metallic for the transmission of direct current is, substantially, 65 per cent. of that of solid copper of equal diameter; its strength, practically four times its weight per mile; but, as mentioned before, this strength is retained, while wires of copper, iron or steel commence to deteriorate when first put into service. The conductivity of bi-metallic wire is sufficient to meet all ordinary uses; its strength will more than counteract the deficiency in electrical transmission. Railway companies, using high voltage and bare wires, require a strong and rigid trolley wire, and, if feeders are employed, bi-metallic, which has both strength and rigidity, also has sufficient conductivity to operate the cars. Where guard wires are specified, bi-metallic will be found suitable for that purpose; it neither corrodes nor stretches, remaining strong always.

Telegraph, telephone and other wires must, necessarily, be carried over railway wires at many points, and such wires are always liable to be broken in storms or by other wires or objects falling upon them. To minimise the danger of falling wires it seems best to strengthen the wire—apparently bi-metallic meets the requirements. Telephonically considered, bi-metallic wire is superior to copper wire, and the users of that wire have secured very good service which, at the same time, is reliable. Bi-metallic wire, possessing about 50 per cent. of copper, is cheaper than copper wire.

* New York *Electrical Engineer*.

THE COLUMBIA ELECTRIC MOTOR CARRIAGE.*

The substitution of mechanical for animal energy for the propulsion of wheeled vehicles intended to travel over common roads is probably pre-eminent among the problems of the day. Ever since the earliest ages man has relied on muscle-power for this purpose, and notwithstanding the development of the various mechanical motive powers and their application to almost every industrial purpose, locomotion over common roads still retains the general principles included in its earliest conceptions. With the introduction of various portable mechanical motive powers, their application to the propulsion of road vehicles has always been one of the earliest suggestions. Previous even to the steam railroad, steam energy was applied to the propulsion of conveyances intended to travel over ordinary roads. Gas and vapour engines were also used during their early development for this purpose, and the appearance of the storage battery used in conjunction with the electric motor seemed to indicate most promising possibilities. Although innumerable motor-propelled road vehicles have been devised and used intermittently, actual serious development has really only taken place within the past 10 or 15 years. The perfection of various light portable motive powers has certainly been a great step in advancing the motor carriage problem.

Motor-propelled road vehicles for business and other purposes, of the type generally known as motor carriages, have for some years past been actively developed on a commercial scale in Europe. General attention has been particularly attracted to them by the various recent races and meets, which seem to have aroused the renewed vigour of the multitude of inventors who place their faith in this substitution of mechanical for animal energy. Many have been the attempts to solve the problem. Steam, gas, electric, compressed air, and many other forms of portable motors have been tried with, in some cases, very excellent results.

For some time it has been well known that one of the largest bicycle manufacturers of the world, the Pope Manufacturing Company, has been actively engaged in the solution of the motor propelled road vehicle problem. After two years of investigation and experiment with various forms of motors, including gas, steam and electric, the Columbia electric motor carriage has been evolved, tried and tested in every detail, to the satisfaction of its designers and builders, who on Thursday, May 13th, publicly exhibited the perfected carriage. No little satisfaction will be experienced by those who put their faith in the electrical vehicle, now that electrical motive power has been adopted after conservative and unbiassed deliberation, and even after experiments had been made with gas and other forms of motive power.

The new carriage takes the form of a modified phaeton, with box body and folding hood. Mechanical appearance is scarcely in evidence, and the design and finish is equal to the highest standard of such work. The upper body of the

* New York *Electrical World*.

carriage is of the box type, with a centrally located double seat, curved dashboard, and comfortably seats two persons. The finish is black carriage enamel. Electric carriage lamps are placed on each side of the seat and also at the centre of the dashboard. Three compound flat springs transversely fastened to the lower frame or truck support the entire upper body, which is not supported at any other point. The separation of the carriage body from the supporting frame, or so-called truck, is an important element in the construction of the vehicle and has peculiar advantages. The entire

Columbia Electric Motor Carriage.

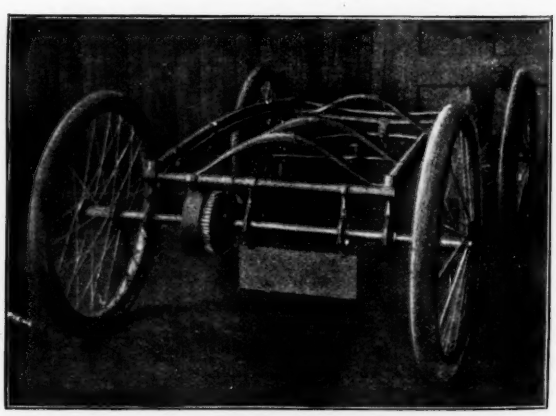
truck is built of steel bicycle tubing made of 50 per cent. carbon steel, and selected in dimensions that enable it to be used in the annealed state. Tubing is also used for all connecting rods and levers wherever possible, but where irregular shapes are necessrry, forgings have been adopted. The sides and front of the frame are constructed of double tubing, rigidly braced and brazed at various points, and bent in such shape as to give the maximum strength with the minimum weight. The rear end of the frame consists of but a single tube, from which hang various supports for the motor, axle bearings and gearing. The body supporting springs, which are placed equi-distant along the frame, are pivotally suspended at each end from the under side of the side tubes.

A particularly notable feature of the vehicle is the use of ball bearings in every possible instance, and wherever any possible advantage would be gained by their use. Not only do all the axles and spindles revolve in ball bearings, but the motor armature and various pivots are also equipped in the same way.

For the operation of the carriage, three devices are provided, easily accessible to the operator, who sits on the left-hand side of the carriage. The vertically-placed lever on the side of the seat is used for operating the motor controller. The nearly centrally-placed handle rod, resembling in appearance an ordinary brake handle such as is used on street cars, is used for steering. At the bottom of the vehicle body close to the dashboard is a pivoted foot-operated lever, which is connected with the brake rod to apply the hand brake on the gear casing fitted to the axle. In conjunction with the operation of the controller lever a peculiar interlocking reversing switch is used, which is operated by means of a foot-push, the action of which will be described later.

Probably the prime and particularly notable feature is the method of driving the vehicle, and the motor used for this purpose. The latter has been most carefully and specially designed, and as manufactured under the specifications of the company, consists of an ironclad casing, which entirely surrounds the field windings and armature, and which is concentrically suspended upon the rear driving axle. The greatest care has been exercised in the design and construction of this motor to produce the highest possible capacity and the minimum of weight, and at the same time a moderate speed. The multipolar field of the motor has been built up of wrought-iron welded by hand. The armature is of the Gramme ring type, current being taken from the commutator by means of two brushes, the windings being inter-connected. The field windings are in sections series connected to the armature. The commutator projects beyond the field magnet frame proper, which is of rectangular form and has at this side an aluminium casing, which completely surrounds the brush and commutator devices. One-half of this casing can be readily unhinged, giving access to the interior of the motor. The field frame is fastened at each side to a hanger from the rear frame tube. The armature is mounted upon a concentric sleeve around the driving axle, but is, however, entirely out of contact therewith, it being supported by means of ball bearings in the previously-mentioned hangers also supporting the field frame of the motor. The hollow armature sleeve projects through the bearing at the end opposite to the commutator and a pinion is fastened thereto, which, in turn, meshes with a larger spur gear on an intermediate spindle, whose motion is then imparted to the balance of the driving gear, to which it is spur connected.

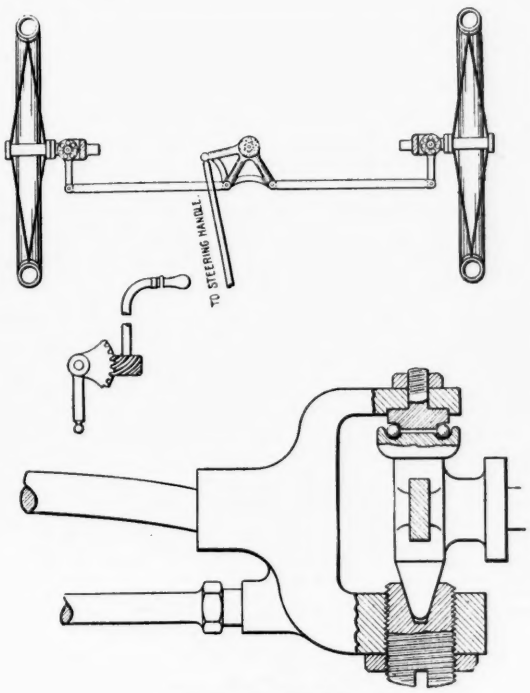
The two rear driving wheels are mounted on a revolving axle, which is split approximately in the centre, and connected to the intermediate gear from the motor, previously mentioned, by means of a balance differential gear arrangement. The two outer hangers from the frame form bearing supports for the axle, ball bearings being used, the compactness of which is to be particularly noted. The balance gear used is of the ordinary so-called "Jack-in-the-box" form,



Frame and Driving Gear.

consisting of two balanced bevels, one connected to each of the driven members, while the centrally driven portion consists of two diametrically opposite bevel pinions rotated in the plane at right angles to that of the side balance gears, with which they mesh. The peculiar construction adopted in this instance consists of an outer casing, the exterior of

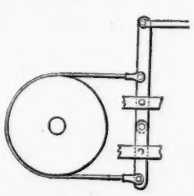
which serves as a brake pulley as well, and to one side of which the spur gear is fastened, co-acting with the intermediate driving shaft. To the interior of the casing is fastened the central portion of the balance gear, and on each side are the driven balance members, the axle being separated about in the centre of the casing, and one of these members being fastened to each end. It will be noted that the axle is additionally supported, aside from the two outer bearings, by means of a ball bearing on each side of the balance gear. The difference in travel of the inner and



Details of Steering.

outer driving wheels in turning curves necessitates the adoption of such balance gearing, owing to the propulsion of both wheels by a single motor, whose operation, it is claimed, far exceeds in effectiveness the use of double motors. The entire gearing is enclosed, but is yet accessible by means of detachable covers in the gear casing.

The vehicle wheels are of the tangent spoke steel rim construction, and are fitted with 3-inch single tube pneumatic tyres. The driving wheels are 36 inches, the steering wheels 32. The wheel track is 54 inches, and the distance between the wheel bases about 6 feet.



Details of Brake.

The brake adopted is of the band type, and of a most unique construction. It consists of a compound steel and leather band surrounding the brake pulley balance gear casing previously mentioned. The brake band is arranged to operate equally well when the brake pulley is driven in either direction. Both ends of the band are, therefore, moved to set the brake in action, which is accomplished through a compound lever arrangement, each end of the brake being fastened to separate levers, which interlock so that the operation of one, to which one end of the brake is connected, also moves the other end of the brake band attached to the other lever in the same direction. The operation of the brake by means of the braking foot-lever is by the direct action of a rod, connecting the two parts.

The front steering wheels of the vehicle are pivoted to a horizontal axletree, which is in turn centrally pivoted to the truck frame, in order to permit of vertical oscillations of the wheels in passing over obstructions on either side. The method of steering that has been adopted is what is known as the short-nut pivoted axle method. Each end of the axletree, which is also built of steel tubing, is a forked forging. Each of the steering wheels revolves on ball bearings on a short axle pivoted to the axletree forks very close to the wheel hub. The strain at this pivot is taken up by ball bearings in the upper pivot. An arm projects from the pivoted portion of the axle at approximately a right angle to the wheel centre, and each is connected by means of a pivoted tubular rod to one arm of a three-armed forging, pivoted on ball bearings at the junction of the arms to the centre of the axletree. The other arm is connected in turn with the previously-mentioned steering handle, which has at its lower end, projecting through the floor of the carriage, a spiral gear meshing into a suitable gear segment at one end of a pivoted lever, the other end of which is connected by means of a rod to the arm on the triangular steering lever previously mentioned. By the peculiar arrangement of this steering device, the wheels, in turning curves, are turned at different angles, so as to prevent the scraping of the wheel tyres. The operation of the steering wheels by the hand is exceedingly easy and rapid, a slight turn to the right or left being all that is necessary under ordinary conditions.

The storage battery equipment consists of 44 chloride cells, arranged in four sets of 11 each, which are fitted in two sliding boxes, and can easily be placed in or taken out of the box through the hinged door at the rear. These cells are specially sealed, and are almost entirely proof against any spilling. The storage battery equipment weighs 850 lbs.,

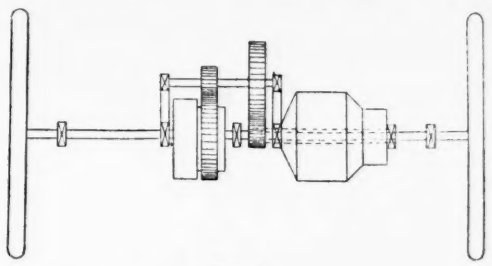


Fig. 1.

and is of the type known as the 3-M cell, which is made up of three plates, two of which are negative. After a long series of tests, the chloride positives and negatives have been adopted. The battery has a capacity of 70 ampere-hours at a discharge rate of 25 amperes. At this rate, the battery will run for about 80 miles of travel at the rate of 12¼ miles per hour. This travelling capacity has been found amply sufficient, after a series of extensive observations.

To operate and control the batteries and motor a cylindrical controller is used, which is arranged to interlock with separate foot-operated reversing switch mechanism. The controller cylinder, in which various contacts are mounted, is turned by means of the operating lever. Connected to the spindle, upon which it is mounted, is a cam, which coacts with certain stop levers connected to the reversing switch. The reversing switch, in its normal position, is set for forward operation of the carriage, and by means of the controller four speeds can be obtained, three miles an hour being the lowest speed, when the four sets of batteries are connected in multiple. The next step on the controller connects two sets in series and the two pairs in multiple, which gives six miles an hour. 12¼ miles an hour is obtained at the next step, which connects all the batteries in series, and the highest speed of 14¾ miles an hour is obtained by throwing the series motor field windings in parallel with each other. If it is desired to reverse the direction in which the vehicle is moving, the operating lever must first be brought back to its normal all-off position before the reversing switch can be operated. After the lever has been brought back, a foot-lever at the side of the seat is pressed downward, throwing over the reversing switch to suitably connect the motor and give an opposite rotation. After this has been accomplished, the controller lever can be again operated, and another of

the previously mentioned speeds can be obtained in the reverse direction. When the controller lever is returned to its normal position the reversing switch automatically returns to the forward contacts. By this arrangement it is impossible to overload the motor by suddenly reversing its connections while going in either direction.

Near the seat is placed a small plug switch for emergency purposes, which can be easily pulled by the operator in case of accident to the motor, which would prevent it stopping otherwise.

Another device which further decreases the liability of injury through ignorance, and makes the complete vehicle more or less fool-proof, which has been the particular aim, is the automatic charging and discharging controlling mechanism. To charge the batteries, a flexible conducting cable of suitable length is furnished with the vehicle. One end of this cable is fitted with plugs of different diameters which fit in their receptacles placed at the rear end of the vehicle immediately below the battery. The batteries are arranged to be charged from an ordinary 110-volt direct-current circuit, which is almost everywhere available, suitable resistance

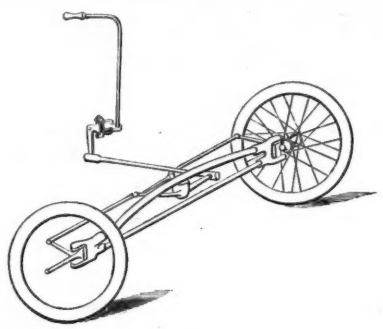


Fig. 2.

being provided, and it is only necessary to connect the charging cable to such supply wires and plug in each of the terminal plugs, it being impossible to make any mistake, owing to the difference in size of each set of plug and receptacle. Immediately under the seat is a small opening through which can be seen the dial of an automatic recording wattmeter. This instrument is arranged to protect the batteries from over-charging and over-discharging. In charging the batteries, as the charge gradually increases, the movement of the wattmeter brings the dial pointer upward until the maximum point is reached, when a contact is automatically made controlling a magnetic switch which automatically disconnects the batteries from the circuit, should the operator have failed to notice the indicator pointer. In discharging the batteries, the wattmeter operates reversely, and indicates by the pointer on the dial the remaining charge in the batteries. The dial can easily be seen by the operator without moving from his seat.

An inspection will readily show the thoroughness with which every detail has been worked out in order to make the vehicle almost entirely automatic, by means of self-operating devices, and to guard against mistakes of any kind being made by persons who may be excited or unfamiliar with the functions of the various parts. It is to be noted that this entire arrangement is covered by patents. A peculiarly interesting feature is the fact that all connections throughout the carriage which have to be manipulated in any way, are made of two different-sized plugs and holes, all of the positives being the larger. A mistaken connection is, therefore, impossible.

The complete carriage weighs about 1,900 lbs., and travelling at 12¼ miles per hour with two occupants, consumes about 18 amperes at 80 volts, the latter being the voltage of the battery when all the cells are in series. Under such conditions the motor will have an output of about 1·93 horse-power. It will operate continuously for 30 miles at an efficiency of about 80 per cent. A particularly notable feature of the motor, however, is the fact that although its rated capacity is 2 horse-power, it readily stands 100 per cent. overload for half an hour without excessive heating. When it is considered that the motor weighs complete only 120 lbs., and has a speed of only 1,000 revolutions, this is a phenomenal performance, and is certainly due to the particular care taken in the construction.

A description of the vehicle would not be complete without a mention of Mr. H. P. Maxim, son of the renowned inventor of that name, to whom the design of all the electrical features and many others used in the construction of the vehicle are due. As showing the thoroughness of construction, and the desire to prevent any future possibilities of accident to the mechanism, the test made of each vehicle should also receive attention. The vehicle at full speed is run over obstructions and it is then also run at full speed over a number of timbers fastened to the factory floor. After this most extreme performance the alignment of all bearings, and the condition of the frame and mechanism generally is tested and levelled, and if found in the slightest way deficient, the construction is rejected. This test is made before the carriage body is completely finished.

At the demonstration, at which all those who were present were permitted to operate the vehicle, it was clearly shown that as far as ease of operation and perfect control are concerned, the vehicle met all reasonable requirements.

The carriage is steered with great ease, and a minimum of muscular effort, by means of the steering apparatus shown in detail in fig. 2. Fig. 1 shows a plan of the rear axle illustrating the relative arrangement of the motor and driving gear.

[These two illustrations are taken from the New York *Electrical Engineer*.—Eds. Elec. Rev.]

ZICKLER'S EQUAL COST DIAGRAM.

The German *Elektrotechnischer Verein* has been discussing the question of the competition of the public supply of electricity with the supply by private installation. It is often an important question to determine whether it is cheaper to take electricity from the mains or to generate on the premises. An interesting diagram has been worked out by Professor Zickler to determine this point. The following is a summary of the account given of Zickler's investigation in the discussion referred to.*

Since the expenditure for interest, depreciation and repairs of the conductors, switches, and lamps, in other words, "the house installation," is the same for a private installation as for a supply from a central station; these are properly left out of account in a comparison of the two. All that is necessary, therefore, is to compare the expenses of the private generating plant with the tariff of the central station.

Consider first, the case of the private installation. Let the maximum capacity of the plant in hektowatts be expressed by z. The capital, P, required for the purchase of the machinery and accessories is a function of the capacity, z, of the installation, *i.e.*,

$$P = f(z).$$

If the installation capital P, is charged with p_1 per cent. for interest; p_2 per cent. for writing off and repairs; p_3 per cent. for salaries and wages of the staff; then the total so called fixed yearly charges, K_1 and K_2 for interest, depreciation, repairs and attendance will be expressed by the equation

$$K_1 + K_2 = \frac{p_1 + p_2 + p_3}{100} f(z).$$

If we make $p_1 + p_2 + p_3 = p$, the fixed yearly charges will be expressed by the equation

$$K_1 + K_2 = \frac{p}{100} f(z).$$

The variable expenditure, K_3, for fuel, lubricants, and cleaners' material, depends on the time per annum during which the installation is working. Since z is the number of hektowatts installed, then if T be the number of hours per annum of supply per lamp or per hektowatt, the product, z, T, will give the annual consumption in hektowatt hours;

* *Elek. Zeit.* 20, May, 1897, p. 296.

and if β represent the expenditure for fuel, β_1, the expenditure for cleaning and lubricating materials per hektowatt hour, the variable expenditure will be represented by

$$K_3 = (\beta + \beta_1)\, z\, T.$$

The total annual cost of a private installation will, therefore, amount to

$$K_1 + K_2 + K_3 = \frac{p}{100} f(z) + (\beta + \beta_1)\, z\, T.$$

Consider now the case where the "house installaton" is connected up to a central station supply. Let a represent the price per hektowatt hour charged by the electrical company in question. Then a supply of z T hektowatt hours will involve a payment to the company of $K^1_1 = a\, z\, T$.

It remains now to give more definite form to the equation

$$P = f(z),$$

which represents the relation of the purchase price of a machine to its capacity in hektowatts. Zickler found, by examining price lists of dynamos, steam engines, &c., that the price of the machinery could be expressed with sufficient exactitude as a linear function of the output, and therefore by an equation

$$P = A\, z + B,$$

where A and B are constants, which have different values according to the type and kind of the machine.

In order to answer the question, when is the cost of lighting by a private plant equal to that from a public supply, the two costs as expressed above are equated, *i.e.*,

$$\frac{p}{100} \cdot f(z) + (\beta + \beta_1)\, z\, T = a\, z\, T,$$

from this by substituting $A\, z + B$ for $f(z)$.

$$T = \frac{p\,[B + A\, z]}{100\,[a - (\beta + \beta_1)]\, z} = \frac{p \cdot B}{100\,[a - (\beta + \beta_1)]\, z} + \frac{p \cdot A}{100\,[a - (\beta + \beta_1)]\, z}.$$

This formula can be simplified by collecting together the factors which are constant for any given case, namely, p_1, a_1, β_1, β_1, A_1 B. Let

$$\frac{p}{100\,[a - (\beta + \beta_1)]} = C,$$

and

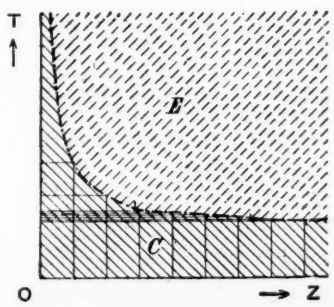
$$C\, B = C_1$$

$$C\, A = C_2$$

The equation given above then becomes

$$T = \frac{C_1}{z} + C_2,$$

which is the equation of a rectangular hyperbola in which the ordinates represent the number of hours per annum per lamp or hektowatt during which the lamps are alight, and the abscissæ, the number of installed hektowatts.



This hyperbola, called by Zickler the curve of equal cost, is traced so that one asymptote coincides with the ordinate axis, and the other asymptote with a line drawn parallel to the abscissa axis at a distance C_2.

Knowing the co-ordinates, T and z, for any given case, we can ascertain the point of their intersection on the diagram. If this point falls in the region, E, above the curve, then a private installation will be the more economical; if the falls in the region, C, below the curve, then the supply from the central station will be the more economical.

Zickler has worked out the value of the constants for a series of types of machines. In the equation for the cost of the installation $P = A\, z + B$, where P is the cost of the installation in shillings, and z the output in hektowatts, the following are values of the constant :—

	Constant A.	Constant B.
Steam engines ...	9·3 – 17·5	975 – 2,400
Portable engines ...	32·3 – 41·9	2,500 – 5,200
Gas engines	28· – 52·3	950 – 3,500
Dynamos	13·0	550

In determining the values of β and β_1, coal is taken at 21s. a ton, gas at ·018 per cbm. (5s. 1½d. per 1,000 cb. ft.), oil and cleaning material at ·005s. per H.P. (736 watts) hour for steam engines, and 0·01s. for gas engines.

The tariff of the Electric Supply Company is taken as a = ·066s., that is, 8d. per kilowatt hour. Interest is reckoned at $p_1 = 4$ per cent.; depreciation and repairs, $p_2 = 10$ per cent.; attendance, $p_3 = 10$ per cent. The total fixed charges, therefore, amount to

$$p = p_1 + p_2 + p_3 = 24 \text{ per cent.}$$

of the installation capital, P.

Since we must add to this cost of the machinery, P, a percentage p^1 per cent. (= 15 per cent.) for foundations, transmission, and other accessories, the first equation

$$P = B + A\, z$$

must be modified to

$$P^1 = \frac{100 + p^1}{100}\,[B + A\, z]$$

The constant, C, acquires in the same way the following value

$$C = \frac{\left(\frac{100 + p^1}{100}\right) p}{100\,[a - (\beta + \beta_1)]} = \frac{(100 + p^1)\, p}{10{,}000\,[a - (\beta + \beta_1)]}$$

The following example of the application of this diagram is given by Zickler. Let a small installation be projected with a gas engine and dynamo; the consumption of gas being 1 cbm. (35·3 cub. ft.) per H.P. hour (736 watt hours) and the efficiency 80 per cent.

Then taking the above-named unit prices.

Cost of fuel

$$\beta = \frac{0{\cdot}18}{736} \times \frac{100}{0{\cdot}8} = 0{\cdot}031\text{s. per hektowatt hour.}$$

Cost of oil and cleaning material

$$\beta_1 = \frac{0{\cdot}01}{736} \cdot \frac{100}{0\,8} = 0{\cdot}002\text{s. per hektowatt hour.}$$

From these figures we get the constants

$$C = \frac{0{\cdot}0115\, p}{a - (\beta + \beta_1)} = \frac{0{\cdot}0115 \times 24}{0{\cdot}066 - 0{\cdot}033} = 8{\cdot}4$$

Since, further, the price of the gas engine is

$$B + A\, z = 950 + 52{\cdot}3\, \frac{z}{0{\cdot}8} = 950 + 65{\cdot}4\, z$$

and of the dynamo is $= 550 + 13{\cdot}0\, z$

the cost of the whole machinery is $1{,}500 + 78{\cdot}4\, z$

for such a gas engine installation the constant $B = 1{,}500$; constant $A = 78{\cdot}4$. The constants for the rectangular hyperbola are, therefore,

$$C_1 = C\, B = 8{\cdot}4 \times 1{,}500 = 12{,}600$$

$$C_2 = C\, A = 8{\cdot}4 \times 78{\cdot}4 = 659$$

and from these the "curve of equal cost" can be easily drawn.

The interpretation of this curve reveals some interesting facts. For instance, the greater the capacity (z) of the installation, *i.e.*, the greater the number of lamps burning simultaneously, the greater is the economical advantage of a private installation. It is also in favour of the private installation when the average number of hours of supply per lamp per annum is great. A curious result which may be deduced from Zickler's curve is that when the average hours alight per lamp per annum exceeds C_2, the private installation is always more economical, except the number of lamps is very small. In the example given, this number of hours is 659. If, however, this number, C_2, be greater than the maximum possible hours alight per lamp per annum, then the central station supply will always be more economical.

Taking the figures given in Zickler's example, it would be possible to produce this result by reducing the tariff from 8d. to 4d. per kilowatt hour, and the tariff assumed in the example appears to be rather high. Zickler thinks it is impossible for central stations to compete successfully with large private installations of say more than 100 H.P. capacity, and supplying more than 1,000 hours per lamp per annum. He thinks that central stations must endeavour to catch such large consumers by some such means as accumulators, which represent a day load.

The moral and intellectual damage to the owner of a private installation has not been taken into account; in the above investigation it has been considered merely from the point of view of pounds, shillings, and pence. The investigation ought to be of considerable interest to electric supply companies.

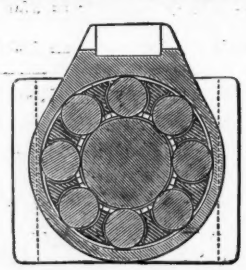
ROLLER BEARINGS.

The advantages of roller bearings have been generally admitted, but the main difficulty hitherto has been to make the rollers last for any length of time. The rolling motion for bearings has been generally adopted by cycle makers, but there seems to be considerable difficulties in the way of using ball bearings for heavy loads. With the economy of the principle so generally accepted, it is not surprising that inventors have striven to make some form of roller bearing that combined facility of movement with lasting power.

On Saturday last we had the pleasure of witnessing a demonstration, at the Crystal Palace, of the special form of bearing which is being made by the Roller Bearings Company.

The exhibit consists of two waggon frames mounted on wheels and axles, which weigh, when loaded with bricks, 5½ tons, and run on a length of light rails borne by steel transverse sleepers. One of these waggons is fitted with ordinary bearings having the usual brasses and oil box, the other being fitted with the company's patent roller bearings. The road in each case has been very carefully levelled, and the object of the exhibit is to show the relative starting effort under precisely similar conditions, both as regards weight and similarity of road.

There could be no denying that the waggon fitted with the roller bearing showed unmistakable superiority as regards ease of movement over the waggon fitted with ordinary bearings, but it seems to us that the results of using this special form of bearings under ordinary working conditions are of much more utility than mere experiments; fortunately, the Roller Bearings Company have abundance of experience of their roller under the most trying conditions, and we shall refer to the various uses that have been made. While the form of the rollers varies to some extent with the kind of work to which it is applied, it may be generally stated that it consists of a series of rollers fixed in a kind of cage which



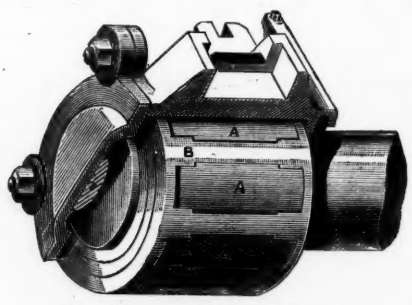
Cross Section of Roller Bearing.

in turn is placed inside the bearing. A rough idea of this form of bearing will be gained from the illustrations. Practically the cage is provided for the purpose of carrying and separating the rollers, thus doing away with the subsidiary rollers which are employed in some other bearings made by the company. It might be observed here that at the exhibit mentioned various kinds of bearings are shown applicable to tramways, line shafting, omnibus axles, and other purposes. There are also two bearings which have been in use on the Liverpool Overhead Railway, and though one has travelled 16,000 miles, and the other something less, neither of them show any perceptible sign of wear.

Mr. Bayley Marshall, in his paper on "Roller Bearings," given before the Civil Engineers Conference last week, records some of the tests that have been made. In railway vehicles the starting effort had been found in many cases to be as low as 3 lbs. per ton of load. The following are the results of careful experiments made to ascertain the relative starting effort and running friction of tramcars fitted with ordinary and roller bearings:—

Starting Effort.—Cars weighing 4 tons 15 cwt.; ordinary bearings, 198 lbs., or 41·68 lbs. per ton; roller bearings, 30 lbs., or 6·53 lbs. per ton.

A gravity test was made in the following manner; a car fitted with ordinary bearings and weighing 2 tons 15 cwt. was let loose from a point 56 feet up an incline with 1 foot 6¼ inches rise. It ran down this incline and 57 feet along the level line at foot of same, or a total distance of 111 feet. The force expended was, therefore, 6,160 lbs. falling through 1·521 foot, or 9,364 foot lbs. The average frictional resistance was 9,364 + 111, or 84 lbs., equal to 30·5 lbs. per ton. A similar car fitted with roller bearings,



Side View of Roller Bearing.

being let loose from the same point, ran the full length of the level line available, namely, 320 feet, and had not then quite come to rest, the total distance traversed being 376 feet. The force expended was about 9,364 foot lbs. The average frictional resistance was 9,364 + 376 = 29·4 lbs., or about 9 lbs. per ton of load.

The experience on the Liverpool Overhead Railway with roller bearings has been so eminently satisfactory that arrangements are being made to fit all the trains with them. The Corporation of Blackpool has had three tram cars fitted and running for over two years, and their consulting engineer certifies that at least 30 per cent. of energy is saved by the use of these bearings as compared with those in ordinary use. The following instances taken from Mr. Marshall's paper show how widespread is the interest taken in roller bearings at the present moment.

The City and South London Electric Railway are now experimenting with roller-bearings applied to their carriages.

The engineers for the Waterloo and City Railway have specified roller-bearings for the whole of the stock ordered for this line.

A passenger train of six carriages fitted with roller-bearings throughout has been running for two years between Brighton and Kemp Town, and has shown a saving of from 12½ to 15 per cent. in the consumption of fuel, which saving has been obtained under disadvantageous circumstances, inasmuch as the engine has to be kept in steam for about sixteen hours, whilst its actual running time is under seven.

The Western Railway of France are fitting a complete train with roller-bearings for experimental purposes, and the report of their engineers will undoubtedly be of great value.

Roller-bearings have been fitted to many horse-cars with results most beneficial to the animals employed, and it is estimated that the use of them would so prolong the life of the horses that the reduction in their depreciation alone would show a saving of considerably over £10 per car per annum.

In general application, perhaps the most interesting is the fitting of roller-bearings to the big bell of St. Paul's Cathedral, "Great Paul," which with its headstock weighs some 25 tons, and which gave considerable trouble when mounted on ordinary bearings.

It would not be difficult to supplement these by other instances, but sufficient has been said to show that the question of roller-bearings has become a real and practical one.

THE BERLINER PATENT.

There are several features in the Berliner Patent case, recently decided by the Supreme Court of the United States, which appear strange to those familiar only with English patents and English Courts. An application for a patent deposited in 1877 becomes the subject of "interference" and argument involving delay in the Patent Office. The patent officers of the Government delay the settlement of the "interference" proceedings from various causes, including litigation on the subject matter of the patent; but eventually the application of 1877 becomes a patent in 1891, with the right to exist for the period of 17 years. On the issuance of the patent it was assumed that it extended the monopoly hitherto held under the Bell patent, and presumably on account of political or other pressure, the extraordinary case was seen of an Executive Government asking the Courts to set aside a patent granted by itself because of the delay of its own servants in its own patent office. The case was decided in favour of the Government in the first instance, this decision being reversed on appeal, and the decision of the Appeal Court upheld by the Supreme Court. The allegation on the part of the Government was that the delay in the issuance of the patent was a fraudulent delay, but the Supreme Court found that there was no evidence to support the allegation, the negative evidence that the applicants not being active in their prosecution was evidence of fraud, was met by the fact that, on the contrary, the applicants had made at least one urgent request for action. It would seem that the delay in the issuance of the patent, with all or any advantage it might bring to the owners, arises naturally from the patent system of the United States, and the Supreme Court had no alternative but to decide the case in favour of the holders of the patent. Their decision will probably be unpopular, but much good law and more sound policy is unpopular. The scope and value of the patent have yet to be determined. The judicial decision settles the existence of the patent. It exists for all it is worth, and on this point there are very divergent views.

DIELECTRIC HYSTERESIS.

It is well known that when a condenser is submitted to a cycle of electrification, some of the energy is converted into heat; the phenomenon has its analogue in the energy lost during the magnetisation of iron, and for this reason it has been attributed to a kind of "hysteresis." The analogy has been pushed so far that some experimenters have been led to regard "dielectric hysteresis" as a complete and sufficient theory of the action; we are glad to see that they are now retracing the steps of the argument, and carefully revising their conclusions. The matter is receiving the attention of Mr. Richard Threlfall in the current number of the *Physical Review;* he states his case very clearly.

Lord Kelvin expressed an opinion, in the course of a discussion at a meeting of the Society of Electrical Engineers some years ago, that the cause of condenser-heating was most likely to be found in the occurrence of internal discharges, rendered possible by the presence of air and moisture in the dielectric. This is the starting point in Mr. Threlfall's argument.

Under certain circumstances, as was shown by M. Bouty, the residual charge in mica condensers may fall to about 80^{-1} of the original charge. It is well known that sulphur has very little "electrification." Comparing, now, mica and sulphur under similar conditions, Mr. Threlfall finds that prolonged drying over phosphorous pentoxide reduces the residual charge of both substances; he has thus been led to make condensers in which, by the simple device of drying, the heating by alternate currents is reduced practically to *nil*. For instance, a 0·123 microfarad condenser, formed from paper soaked in vaseline and hard paraffin, when submitted to an alternating potential of 3,000 volts at 60 ~ per second, did not rise in temperature more than 0·2° C. per hour. As compared to tests made on ordinary undried condensers, this is a very remarkable result.

That a distinction ought to be drawn between "residual charge" and "creeping surface charge" is probably well known to most of us, it was taken account of in the investigations by Rowland and Nichols (*Phil. Mag.*, 1881, Vol. 12, p. 418). The question now suggested by Mr. Threlfall is as follows:—"When surface action is properly guarded against, and an elementary volume of a dielectric is carried round a cycle of electric polarisation, is it true that some of the energy of electrification is converted into heat, or, at all events, disappears?"

There has been too great a tendency to take things for granted. Steinmetz measured the phase angle between current and potential difference in a paraffin-paper condenser circuit by a dynamometric method, and deduced the condenser losses. The insulation resistance of the condenser was determined by means of a steady electromotive force of the same order as the alternating potential difference. According to Mr. Threlfall, the results thus obtained by no means prove the existence of dielectric hysteresis; they are quite fallacious, on the grounds of uncertainty of resistance, and the greater part of the losses are probably due to creeping and air discharges.

Riccardo Arno is dealt with in a similar manner; his conclusions, as distinguished from his experiments, have been sharply criticised by M. Hess in *L'Eclairage Electrique*, June, 1896; it will be remembered that Arno rotates cylinders of dielectric material in an electrostatic field of alternating potential, and by comparing his results with those obtained by Ewing and Miss Klassen for iron in a magnetic field, he concludes that he is dealing with "static" dielectric resistance. In his later experiments the Italian physicist finds that the energy decreases as the speed of rotation increases, both at low and high potential differences, and he is thus led to reconsider his earlier conclusions.

We have before us only Part I. of Mr. Threlfall's article, Part II. is promised for the next number of the *Physical Review;* judging from the thorough manner in which he is attacking the problem, collecting data, and testing the experimental work, he will reduce "dielectric hysteresis" to a very small quantity indeed.

THE APOSTOLOFF AUTOMATIC TELEPHONE SYNDICATE.

From time to time there have been announcements of important inventions in connection with automatic telephone exchange apparatus, and comparatively recently the inventor of an impossible submarine boat was understood to be launching a company for the purpose of acquiring and developing his inventions in the telephonic field. We were not aware that the company had been publicly subscribed, but it is announced that an extraordinary general meeting of the Apostoloff Automatic Telephone Parent Syndicate will be held at Winchester House to-day, for the purpose of considering the transfer of the business to a new company. The nominal capital of the new company will be £100,000, in ordinary shares of 5s. each. Three-fourths of the capital will be absorbed in the purchase. Shareholders in the "syndicate"—or selling—company are to have an interest of 5 to 1 in the new company, and are alone to be accorded the privilege of subscribing at par to the £10,000 "working capital" necessary for the new company. The directors have decided to offer "an additional but limited" number of fully paid shares at a premium, and these shares will be put up to auction at the meeting. It is probably due to the limited number that the shares "will be offered in small parcels, convenient to all shareholders." Other information is given in the secretary's circular accompanying the notice of meeting, from which the above particulars are taken, such as that Mr. Max Margowski, the managing director of the Parent Syndicate, has consented to take the same position in the new company, and that two directors will be elected by the shareholders who subscribe to the £10,000 working capital.

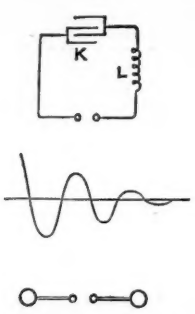
It is to be hoped that the exceptional methods adopted may cause intending shareholders to inquire closely into the nature of the company for which they are asked to subscribe working capital. There is always something tempting about automatic apparatus, but if any shareholder would take the trouble to consider the nature of exchange communications

he would have little difficulty in understanding how unpromising is the telephone exchange for automatic working on other than the very smallest scale. Workable systems of limited extent and limited utility have been in operation for some years past, but we are not aware that the Apostoloff system has ever been used on a practical scale, that any satisfactory demonstration of its utility has been made, or that there is any evidence that its inventor has had the practical experience of telephone working which would justify credence being given to his statements of what the apparatus is capable of accomplishing. Before any investor provides working or any other capital for a venture of this sort, he should be satisfied by independent testimony that the invention is of proved value, that the management is more than usually capable, and that the *bonâ fides* of the inventor is beyond question. We believe that an Apostoloff automatic telephone system has been heard of on the Continent for many years past. To what extent has it been used?

ELECTRICAL RESONANCE.

It is a commonplace of the historian of scientific progress that new phenomena which are to-day of interest only to the pure scientist, and appear to have no *raison d'être* outside the laboratory, form to-morrow the basis of some far reaching application which may revolutionise some branch of human industry, and form an important link in the chain of our material progress. The electric lighting stations which to-day supply power to every part of our great cities, trace their genealogy to a few curious experiments made by Faraday in the Royal Institution laboratories some 65 years ago, and such examples may be multiplied indefinitely. The phenomena of electrical "resonance" serve as an illustration, on a smaller scale, of this kind of development.

The work of Hertz has made us familiar with some aspects of this peculiarly interesting effect. It depends ultimately upon the phenomenon of oscillatory discharge. When a circuit containing capacity and self-induction, as indicated in fig. 1, is allowed to discharge through a spark-gap, the



Figs. 1, 2, and 3.

discharge will be of an oscillatory character, unless the resistance exceeds a certain value. Fig. 2 represents the character of the alternating and gradually diminishing displacements. Precisely the same effects accompany the discharge of a "circuit" such as is represented in fig. 3, which shows one form adopted, when, in order to get the most rapid oscillations, it is necessary to reduce both the self-induction and capacity to the smallest limits. The period of one oscillation is approximately $2\pi\sqrt{K L}$, where K is the capacity and L the self-induction. Any such circuit has, therefore, a definite natural rate of vibration, like a tuning fork or an organ pipe, and is even, like them, capable of giving rise to overtones or harmonics in addition to its fundamental note.

When set vibrating, the circuit radiates energy in the form of electro-magnetic waves of definite wave length or "pitch," to adhere to the acoustic analogy. Now, the researches of Hertz have shown that if we place in the path of these waves a second circuit "tuned" (by adjustment of its self-induction or capacity) to the same frequency of vibration as that which originates the waves, oscillations will be set up in the second circuit of far greater amplitude than would occur in a circuit having any other period of natural vibration. The second circuit is, in fact, resonant to the waves produced by the oscillator just as an organ-pipe is resonant to another of the same pitch sounded in its neighbourhood. The point at which resonance occurs is well defined, as seen in fig. 4,

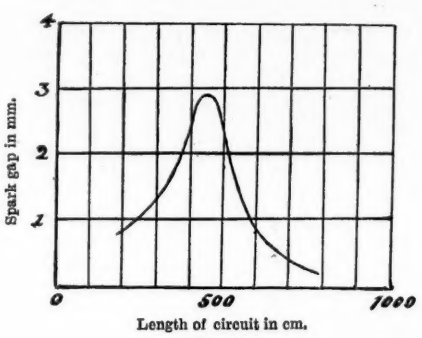


Fig. 4.

which records the result of Hertz's experiments on the variation of sparking distance in a rectangular circuit tuned to resonate with a particular oscillator by varying its length.

We need not dwell upon the mechanical and other analogies to these phenomena that naturally present themselves. The effects produced by the cumulative action of small forces periodically impressed upon bodies whose oscillations synchronise with the impressed force are well known. A bridge of the suspension or cantilever type may, for example, be thrown into dangerous vibration by the passage of large bodies of men marching in step, if the natural period of vibration happens to coincide with, or be a multiple of, the period between the successive impulses. So well is this gigantic resonance effect recognised, that armed bodies invariably break step when traversing any structure of that character.

There is another class of electrical phenomena grouped under resonance effects which differ somewhat from those to which we have referred above. The Hertzian oscillators and resonators work at enormous frequencies, the period of oscillation being usually a small fraction of the millionth part of a second. Resonance effects manifest themselves, however, in alternate current working at the enormously lower frequencies that are employed in practice. It is well known that the effect of self-induction in an alternating current circuit in "choking" or reducing the current can be neutralised by inserting a condenser in series with it. Self-induction produces a lag of the current behind the phase of the E.M.F.; capacity gives it an advance or "lead." If both are present a certain relation between them will bring the current into phase with the pressure, and under these circumstances the current is a maximum, being, in fact, merely the quotient of the E.M.F. by the ohmic resistance of the circuit. Calculation shows that the maximum current will flow when the capacity, self-induction, and frequency are so related that $\frac{1}{K p} = L p$, where p is the familiar $2\pi n$ that finds its way into most alternating current equations. This gives:—

$$p = \frac{1}{\sqrt{K L}} \quad \text{or} \quad n = \frac{1}{2\pi\sqrt{K L}}$$

This last equation gives the frequency that will produce maximum current in the circuit in terms of its capacity and self-induction. We may write it $T = 2\pi\sqrt{K L}$, where T is the period of an alternation.

This equation is, however, precisely that which gave us the natural period of a vibration in the case of the Hertz oscillator. Hence we see that this maximum value of the current may be regarded as a resonance effect. The natural period of the circuit is the same as that of the impressed E.M.F., and the electric displacement produced is in consequence largely increased.

This question of resonance at low frequencies came into some prominence in connection with the "Ferranti effect," or rise of pressure observed on the Deptford mains, and as an interesting parallel to the curve in fig. 4, we reproduce a

curve (fig. 5) given in Dr. Fleming's paper, read in 1891 before the Institution of Electrical Engineers, and dealing with that subject among others. The curve shows the variation produced in the voltage of the secondary of a transformer, the primary of which was across the terminals of an alternator working at constant speed and excitation, by varying the capacity across the secondary terminals. The resonance of the system is very marked, with a capacity of 0·2 microfarads.

Mr. Kempster B. Miller, in a paper read before the Chicago Electrical Association in March last, deals with some practical aspects of electrical resonance. A combination of an inductive coil and condenser may be regarded as

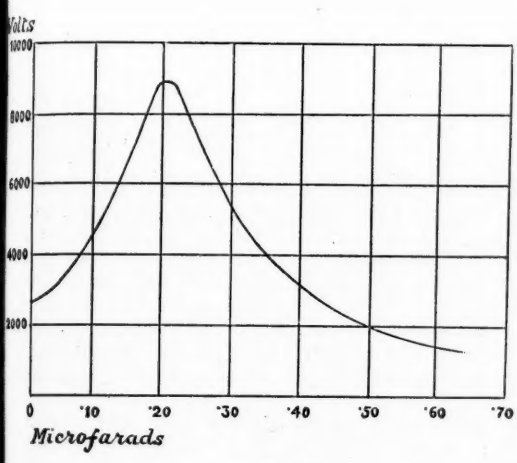


Fig. 5.

a kind of selector for alternating currents. *It picks out a current of one particular frequency and allows it to pass, rejecting all others.* This is, of course, not strictly true, the peak in the curve is not so sharp as to make it more than an approximation to the truth, but it is, in so far as this selective action is obtained, that the practical application of electrical resonance is possible. In the drawings accompanying the British patent specification, No. 6,888, '94, which embodies the results of some of M.M. Hutin and Le Blanc's

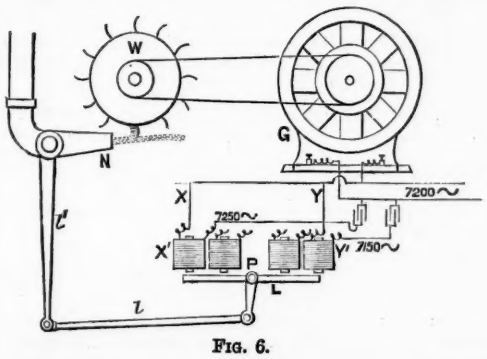


Fig. 6.

work on multiple telephony and telegraphy, is shown a charmingly peaked curve, highly suggestive of Cleopatra's Needle, but it is not clear that this curve is other than the expression of M.M. Hutin and Le Blanc's ideal.

Mr. Miller proposes to use the principle of resonance in the governing of water-wheels, electromotors, steam engines, &c. Fig. 6 illustrates diagrammatically the governing of a Pelton wheel, W, driving an alternator, G. The standard frequency is 7,200 ~ per minute. Circuits, X, Y, across the mains are tuned to frequencies of 7,250 and 7,150 respectively. The solenoids, X', Y', operate differentially on the lever, L, pivoted at *p*, and by means of arms, *l*, *l'*, the nozzle, N, is approached to or withdrawn from the buckets according as the frequency is too low or too high.

Incorporated in the paper is a short account of M.M. Hutin and Le Blanc's work on the utilisation of resonance in multiplex telegraphy and telephony. We would refer our readers for a full account of their most interesting systems, to the admirably drawn British patent specifications, Nos. 23,892, '92, and 6,888, '94, and the U.S.A. specification, No. 522,564. The system of multiplex telegraphy described in these specifications may be briefly described as follows:—Let there be four stations, A, B, C, D, branching from a common line. The *receiving* Morse or other instrument at station A is permanently in series with a selector tuned, say, to frequency

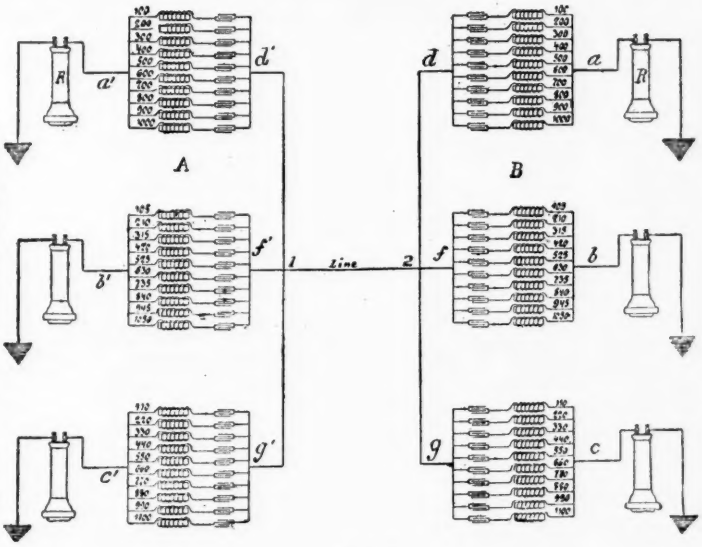


Fig. 7.

10,000, those at B, C, D, to 20,000, 30,000, 40,000. Thu each instrument can be operated only by a current of one particular frequency. By means of suitable alternators and transformers the line is provided with alternating E.M.Fs. of the four frequencies named. At station A the *signalling* key can be thrown in circuit with selectors tuned either to 20,000, 30,000, or 40,000 frequency, and similarly, *mutatis mutandis*, at the other stations. Thus if A wishes to send to C, the selector 30,000 is used with the signalling key, that being the number of C's receiver, and a current then flows on the line between A and C. Signals proceeding between any other pair of stations on the line will not affect the receiving instruments of either A or C. The same principle is applied to telephony. The sounds due to the high frequency currents are inaudible; what is heard is due to variations in the strength of the current produced by the transmitting microphone. These are superposed upon the high frequency waves, which are rejected by all the instruments on the line but the one determined upon at the sending station.

For telephone work, however, M.M. Hutin and Le Blanc propose a system such as that shown in fig. 7. In this case subsidiary currents are not employed. The current wave from each telephone on the line, 1, 2, has to run the gauntlet of a series of selectors which weed out all component waves but a definite series. Thus telephone R only sends to line an approximation to the original wave, built up of waves having frequencies 100, 200, 300, 400, &c. Another telephone may work with frequencies 105, 210, 315, 420, and so on. The telephone R' alone can receive the wave sent to line from telephone R, since its selectors alone can pass the components of that wave. Thus the three instruments shown at station A can simultaneously speak to the three at station B, each of the latter giving out a sound approximating to the sound received by its corresponding instrument, and being proof against all others. The extent to which the sound received approximates to the original depends upon the number of selectors employed at each station. By providing each station with a complete set of all the

groups of selectors in use on the line, and using in series with the speaking telephone that group which corresponds to the receiving instrument of the station to which it is desired to speak, any desired station can be spoken to, and a complete system of multiplexing obtained.

This exceedingly ingenious application of the principles of electrical resonance and harmonic analysis is, we fear, at present of theoretical rather than of practical interest, the tuning of the selectors within sufficiently narrow limits being practically impossible, but, to quote Mr. Miller's peroration, "whether the ideas are practicable or impracticable, no one can deny the beauty of the conception and the nicety with which known physical laws have been utilised in this effort to bring the telephonic art to a higher degree of perfection."

CORRESPONDENCE.

Mounting Machinery on Springs.

Apropos of Mr. J. Swinburne's suggestive paper about "Mounting Machinery and Engines on Springs," may I state that I approached this subject in two articles on the "Vibration of Engine Foundations," contributed to your Journal in July of last year. I there discussed the nature of the vibrations communicated to the foundations by ordinary types of reciprocating engines; and the possibility of isolating them from surroundings.

Briefly stated, the conclusions I arrived at were that it is possible to isolate vibrations in the horizontal plane, also true rocking vibrations about a point or line of support at the centre or axis of gravity of the mass; while it is impossible to isolate vertical vibrations by any means whatever.

In the first case, it is simply necessary to mount the foundation block on rollers, balls, or the equivalent, so that it is entirely free to move in the horizontal plane. I explained, further, that these conditions may in many cases actually obtain in practice. For, since the amplitude of the vibration is very small, in dry sandy soils we have an equivalent to the roller support, and the foundation works itself free at the sides.

Now, in the case of vertical vibrations, there is absolutely no method of preventing or subduing the vibrations of pressure upon the supporting earth. Interposing springs or cushions cannot effect this purpose, for their reaction upon the support is as forcible as the original impulse. This is what Mr. Swinburne and others overlook when they suggest spring suspension as a remedy. The huge foundation block at Manchester Square, in wet weather, rests on a most effective hydraulic cushion; but it was this very cushion which emphasised the mischief. Mr. Swinburne, and electrical engineers in particular, will understand me, I think, perfectly, when I submit that springs and cushions merely delay the phase of the transmitted vibration; but they cannot annul it.

Hence the simplest and most practical safeguard against propagating vibration beyond the engine room—other than an efficient balancing of all momenta in the engines themselves—lies in the resolution of all the vertical components of the unbalanced momenta of the mechanism into horizontal components; and in the rigid attachment to foundations of large mass, well bonded together in all directions, built on a level layer of sand, and free of adjacent masses of masonry or rock. If the vibration be of rocking character, the bottom of the foundation block should be curved concentric with the centre or axis of gravity of the rocking mass; likewise bedded in a depression lined with sand.

I say the foundations should be of large mass advisedly, bearing in mind the safety and permanence of the steam pipe and other connections. Otherwise there is no objection to mounting the engine bed-plate itself direct on balls or rollers, leaving it quite free to move horizontally. But there is no advantage in this, such as I understand Mr. Swinburne to claim, viz., that the so-called inertia stresses on the bearings are thereby reduced. For the value of the two equal momenta in opposition, and therefore the dynamic pressure on the bearings, is not altered with different relations between the masses and their movements. Besides, in very few cases indeed would such arrangement be practicable. To avoid serious difficulties with the connections, the amplitud of the vibratory movements must be kept within very small limits, which can only be done by weighting down the engine with massive foundations or other heavy and rigid attachments.

The resolution of unbalanced vertical into unbalanced horizontal momenta is effected by revolving counter-weights. It is noteworthy that common engineering practice is in a contrary direction. Makers of horizontal engines "balance" them, as they say, by a rotating counter-weight, *i.e.*, they substitute unbalanced vertical momenta for the horizontal; while vertical engines are not so balanced. The reason is, perhaps, not far to seek. Unpleasant experiences have probably shown that want of balance horizontally is apt to cause loose bolts, and is more destructive generally to ill-built foundations. Vertical vibrations are less so, because directly opposed to solid earth and the weight of the engine, and having no shearing action. And the cases in which it is of any concern whether vibrations are transmitted to surroundings, are comparatively very few indeed, outside of marine and locomotive practice.

After all is said and done, the proper place to attack the problem of vibration is in the mechanism or engine itself. And once the mechanical value of perfect balance is appreciated by engineers generally, this is where it will be met. Often the problem may be complex and involved; yet, boldly faced, it does not seem to me that the obstacles are too great to be surmounted, and that by reasonable and practical means.

James Whitcher, A.Inst.E.E.

Beeston, Notts, *May 31st.*

Uninsulated Pipes for Electric Wiring.

We notice in your issue of the 21st ult. an article on uninsulated pipe installations in which our work in this field is referred to.

While appreciating the compliment your correspondent has paid us, we should like to state, with your permission, that while in our experience we have found bare pipes most suitable in many cases, it is no more adaptable for all circumstances than are insulated pipe, casing, concentric, or any other good system.

Handcock & Dykes.

ON THE CAPACITY AND RESIDUAL CHARGE OF DIELECTRICS AS AFFECTED BY TEMPERATURE AND TIME.*

By J. HOPKINSON, F.R.S., and E. WILSON.

Before describing the experiments† forming the principal subject of this communication, and their results, it may be convenient to shortly state the laws of residual charge.

Let x_t be the potential at any time t of a condenser, *e.g.*, a glass flask, let y_t be the time integral of current through the flask up to time t, or, in other words, let y_t be the electric displacement, including therein electric displacement due to ordinary conduction. If the potential be applied for a short time ω, let the displacement at time t, after time ω has elapsed from the application of force $x_{t-\omega}$ be $x_{t-\omega}\,\psi\,(\omega)\,d\,\omega$; this assumes that the effects produced are proportional to the forces producing them; that is, that we may add the effects of simultaneously-applied electromotive forces. Generalise this to the extent of assuming that we may add the effects of successively-applied electromotive forces, then $y_t = \int_0^x x_{t-\omega}\,\psi\,(\omega)\,d\omega$. This is nothing else than a slight generalisation of Ohm's law, and of the law that the charge of a condenser is proportional to its potential. Experiments were tried some years ago for the purpose of supporting this law of superposition as regards capacity. It was shown that the electrostatic capacity of light flint glass remained constant up to 5,000 volts per millimetre (*Phil. Trans.*, 1881, Part II., p. 365). The consequences of deviation from proportionality were considered (*Proceedings*, Roy. Soc., 1886, Vol. 41, p. 453), and it was shown that, if the law held, the capacity as determined by the method of attractions was equal to that determined by the method of condensers; this is known to be the case with one or two doubtful exceptions (*ibid.*, p. 458). Rough experiments have been made to show that

* Royal Society Paper. Received December 15th, 1896—Read January 28th, 1897.

† These experiments were commenced in the summer of 1894, and we have to thank Messrs. C. J. Evans and R. E. Shawcross for valuable assistance rendered during the period of their demonstratorship in the Siemens Laboratory, King's College, London.

residual charge is proportional to potential; they indicate that it is (*Phil. Trans.*, Vol. 167, Part II.) The integral $y_t = \int_0^\infty x_{t-\omega}\,\psi(\omega)\,d\omega$ includes in itself ordinary conduction, residual charge and capacity. Suppose that from $t = 0$ to $t = t$, $x_t = \mathrm{X}$, and before that time $x_t = 0$, then $y_t = \mathrm{X}\int_0^t \psi(\omega)\,d\omega$, and $\frac{d\,y_t}{d\,t} = \psi(t)$; thus $\psi(t)$ is the conductivity after electrification for time t. It has of course been long known that in stating the conductivity or resistance of the dielectric of a cable, it is necessary to state the time during which it has been electrified; hence $\psi(t)$ is for many insulators not constant. $\psi(\infty)$ may perhaps be defined to be the true conductivity of the condenser, but at all events we have $\psi(t)$ as the expression of the reciprocal of a resistance measurable, if we please, in the reciprocal of ohms. For convenience we now separate $\psi(\infty) = \beta$ from $\psi(\omega)$ and write for $\psi(\omega)$, $\psi(\omega) + \beta$. If we were asked to define the capacity of our condenser we should probably say: "suppose the condenser be charged to potential X for a considerable time and then be short-circuited, let Y be the total quantity of electricity which comes out of it, then Y/X is the capacity." If T be the time of charging $y_t = \mathrm{X}\int_0^T \{\psi(\omega) + \beta\}\,d\omega$ at the moment of short circuiting; $y_t = \mathrm{X}\int_t^{T+t} \{\psi(\omega) + \beta\}\,d\omega$ after time t of discharge. The amount which comes out of the condenser is the difference of these, or $\mathrm{Y} = \mathrm{X}\left\{\int_0^T \psi(\omega) + \beta\,d\omega - \int_t^{T+t} \psi(\omega) + \beta\,d\omega\right\}$; if t be infinite $\psi(t) = 0$, and $\mathrm{Y} = \mathrm{X}\int_0^T \psi(\omega)\,d\omega$; or we now have capacity expressed as an integral of $\psi(\omega)$ and measurable in microfarads, and it appears that the capacity is a function of the time of charge increasing as the time increases. Experiments have been made for testing this point in the case of light flint glass, showing that the capacity was the same for 1/20000 second and for ordinary durations of time (*Phil. Trans.*, 1881, p. 356), doubtless because $\int_{1/20000}^\infty \psi(\omega)\,d\omega$ is small compared with $\int_0^{1/20000} \psi(\omega)\,d\omega$. Now $\int_0^t \psi(\omega)\,d\omega$, when t is indefinitely diminished, may be zero, have a finite value or be infinite; in fact, it has a finite value. The value of $\psi(\omega)$ when ω is extremely small can hardly be observed; but $\int_0^t \psi(\omega)\,d\omega$, when t is small, can be observed. It is, therefore, convenient to treat that part of the expression separately, even though we may conceive it to be quite continuous with the other parts of the expression. $\int_0^t \psi(\omega)\,d\omega$, when t is less than the shortest time at which we can make observations of $\psi(\omega)$, is the instantaneous capacity of the condenser. Call it K and suppose the form of ψ to be so modified that for all observed times it has the observed values, but so that $\int_0^t \psi(\omega)\,d\omega = 0$, when t is small enough.

Then $y_t = \mathrm{K}\,x_t + \int_0^\infty x_{t-\omega}\,\{\psi(\omega) + \}\,d\omega$. Here the first term represents capacity, the second residual charge, the third conductivity, separated for convenience, though really all parts of a continuous magnitude. Suppose now our condenser be submitted to a periodically varying electromotive force, that

$$x_t = \mathrm{A}\cos p\,t,$$

then

$$y_t = \mathrm{A}\left\{\mathrm{K}\cos p\,t + \int_0^\infty \cos p\,(t-\omega)\,[\psi(\omega) + \beta]\,d\omega\right\}$$

$$= \mathrm{A}\left\{\mathrm{K}\cos p\,t + \cos p\,t\int_0^\infty \cos p\omega\,\psi(\omega)(d\omega + \sin p\,t\int_0^\infty \sin p\omega\,\psi(\omega)\,d\omega\right\}.$$

The effect of residual charge is to add to the capacity K the term $\int_0^\infty \cos p\,\omega\,\psi(\omega)\,d\omega$, whilst the term $\sin p\,t\int_0^\infty \sin p\,\omega\,\psi\,\omega\,d\omega$ will have the effect of conductivity as regards the phases of the currents into the flask. Thus the nature of the effect will depend upon the form of the function $\psi(\omega)$. An idea may be obtained by assuming a form for $\psi(\omega)$, say $\psi(\omega) = \frac{\mathrm{C}}{\omega^m}$, where m is a proper fraction. This is a fair approximation to the truth. Then

$$\int_0^\infty \cos p\,\omega\,\psi(\omega)\,d\omega = \Gamma(1-m)\cos(1-m)\,\pi/2/p^{1-m},$$

$$\int_0^\infty \sin p\,\omega\,\psi(\omega)\,d\omega = \Gamma(1-m)\sin(1-m)\,\pi/2/p^{1-m},$$

If m is near to unity, capacity is almost entirely affected; otherwise the effect is divided between the two, and dissipation of energy will occur. It is interesting to consider what sort of conductivity a good insulator such as light flint glass, according to this view of capacity, residual charge, and conduction, would have at ordinary temperatures if we could measure its conductivity after very short times of electrification; if, in fact, we could extend the practice used for telegraph cables and specify that the test of insulation should be made after the one hundred millionth of a second instead of after one minute, as is usual for cables. The capacity of light flint measured with alternating currents with a frequency of two millions a second is practically the same as when measured in the ordinary way; that is, its capacity will be 6·7. Its index of refraction is 1·57 or $\mu^2 = 2{\cdot}46$, or, say, 2·5. We have then to account for 4·2 in a certain short time. The current is an alternating current, and we may assume as an approximation that it will be the residual charge which comes out in one-sixth of the period which produces this effect on the capacity; therefore $\int_0^{1/12\times10^6} \psi(\omega)\,d\omega = \frac{4{\cdot}2}{6{\cdot}7} \times$ capacity of the flask as ordinarily measured. The capacity of a fairly thin flask may be taken to be 1/1,000 microfarad to 2/1,000 microfarad; hence we may take $\int_0^{1/12\times10^6} \psi(\omega)\,d\omega$ to be 10^{-9} farad; if $\psi(\omega)$ were constant during this time its value must be $12 \times 10^6 \times 10^9 = \frac{1}{5\cdot0}$ ohms^{-1} about. The value of $\psi(\omega)$ is far from constant, and hence the apparent resistance of that extraordinarily high insulator, a flint glass flask, must be, for very short times, but still for times enormously large compared with the period of light waves, much less than 80 ohms.

[Added March 11th, 1897.—Somewhat similar considerations are applicable to conduction by metals. Maxwell pointed out that the transparency of gold was much greater than would be inferred from its conductivity measured in the ordinary way. To put the same thing another way—the conductivity of gold as inferred from its transparency is much less than as measured electrically with ordinary times. Or the conductivity of gold increases after the application of electromotive force. Suppose then we have a current in gold caused by an electromotive force which is increasing, the current will be less than it would be if the electromotive force were constant, by an amount approximately proportional to the rate of increase. If u be the current, ξ the electromotive force, $u = a\,\xi - \beta\,\xi\cdot$ where a is the conductivity as ordinarily measured. This gives us the equation of light transmission $a\,\xi\cdot - \beta\,\xi\cdot\cdot = \frac{d^2\xi}{dx^2}$ assuming that we have no capacity in gold.

Prof. J. J. Thomson gives as a result of some experiments by Drude that the capacity of all metals is negative. This conclusion is just what we should expect, if we assume, as Maxwell has shown, that the conductivity of metals increases with the time during which the electromotive force is applied.]

The experiments herein described are addressed to ascertaining the effect of temperature, first on residual charge as ordinarily known, second on capacity as ordinarily known, third to examining more closely how determinations of capacity are affected by residual charge, fourth to tracing the way in which the properties of insulators can continuously change to those of an electrolyte as ordinarily known. The bodies principally examined are soda-lime glass, as this substance exhibits interesting properties at a low temperature, and ice, as it is known that the capacity of ice for such times as one-tenth of a second is about 80, and for times of one-millionth of a second of the order of three or less.

(To be continued.)

LEGAL.

Weekes *v.* Adams.

On Monday, in the Queen's Bench Division, before Mr. Justice Wills sitting for the trial of non-jury cases, the case came on for hearing of Weekes *v.* Adams and others. This was an action brought by the plaintiff, Mr. Robert Weekes, the author of a book entitled "Alternate Current Transformers," against George Adams, the author, and Messrs. E. & F. Spon, the publishers of another book entitled "Transformer Design," for an infringement of the copyright in the plaintiff's book, and for an injunction restraining further infringement. The defence was a denial that there had been any infringement of copyright. Mr. Grey was counsel for the plaintiff and Mr. Adams represented the defendant.

Mr. Grey, in opening the case, said the matter was one which depended entirely on a comparison of the two books, which were somewhat technical. He proposed to show his Lordship that not only were the theorems and problems dealt with in the plaintiff's book copied, but that in 40 of the instances, although the work was a very small one, the design of the defendant's book was substantially the same; in some 10 or 11 cases the paragraphs being word for word exactly the same, the very mistakes made by the plaintiff in his book having been in some cases copied by the defendants. Within the last 10 or 15 years, said counsel, the subject of alternating currents in connection with electric lighting had been fully developed. Fifteen years ago there were no transformers of any kind, but transformers had now been invented which transformed from high to low electric pressure. Thirteen years ago, the first practical transformer was invented, and from that time up to now a good deal of attention had been given to the theory of transformers in order to make them commercially valuable. The theory, however, was so abstruse and so mixed, that it was practically impossible for an electrical student or engineer to be able to get advantage from reading papers on that account. Till the date of the plaintiff's book there was no elementary hand-book which was accessible to the average electrical engineer or student, and at the present time the only other hand-book, with the exception of the plaintiff's and defendants, which was now in existence, was one by a well-known electrician of the name of Kapp. He hoped to prove to his Lordship that the plaintiff's book was not merely a compilation from previous books, but that it was original both in design and in the treatment of the subject. Even in 1897, which was the date of the publication of the defendant's book, the transformer was practically in its infancy so far as the knowledge of the practical electrical engineer was concerned.

Mr. J. Swinburne was called on behalf of the plaintiff, and cited instances in which the defendant's treatment of the subject was identical with that of the plaintiff.

The plaintiff was called and asked by the defendants' counsel if it was not the fact that before the defendant's book was published, witness was shown the manuscript by a publisher to whom it had been offered, so that he might express an opinion upon it?—Witness replied that it was the fact that the manuscript was shown him, and he then told the publisher in question that the defendant had copied portions of witness's books, and that where he had not so copied he did not agree with the defendant.

Replying to his Lordship, Witness said that after seeing the manuscript he did not write to the defendant complaining that the latter had infringed his copyright, because when he glanced through the manuscript he did not read it closely, and was not, therefore, aware that the defendant had appropriated so largely from his book as he subsequently found that he had done.

Mr. Adams, for the defendant, did not call any evidence, but confined himself entirely to the legal aspect of the question. At the outset he contended that there had been no infringement of copyright. It was almost inevitable that when two persons were writing on the same subject under circumstances such as these there must be a similarity of words.

Mr. Justice Wills observed that it would be little short of a miracle if by accident these coincidences could be repeated to the extent that they were in defendant's book.

Mr. Adams contended that every formula in plaintiff's and defendant's book were formulæ which simply represented an obviously well-known fact known throughout the electrical world, and no harm was done to the plaintiff by the defendant if, in describing a formula, he happened to use substantially identical terms.

Mr. Justice Wills, in giving judgment, observed that a very considerable allowance must be made for persons who were writing books on technical subjects, but he could not consider that a fair use had been made of the work of the plaintiff by the defendant. In many instances not only had there been an absolute identity of language or figures used, where men of independent mind would have been bound to have adopted different words in which to clothe their thoughts; but there had been a slavish adherence by the defendant to the form set forth by the plaintiff. He thought that unfair use had been made of the plaintiff's book; that there had been an undue amount of copying, and that when there had been a variation, it seemed to him a colourable attempt to make what had been really copied look as if it was original. Under all the circumstances he thought the plaintiff had made out his case, and was entitled to the injunction which he claimed. Judgment was accordingly given for the plaintiff with costs.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending June 1st, 1896.	£	s.
Albany	38	0
Amsterdam	60	0
Bombay	63	0
Brisbane. Sub. cable ...	1,411	0
Cape Town	180	0
Colombo...	107	0
East London	233	0
Gothenburg. Teleg. mat.	135	0
Melbourne	123	0
„ Teleg. mat. ...	294	0
Otago	46	0
Paris	147	0
Rotterdam	10	0
Singapore	34	0
Suez	25	0
Sydney	706	0
Wellington	19	0
Yokohama	138	0
Total	£3,769	0

Week Ending June 1st, 1897.	£	s.
Albany	47	0
Alexandria. Teleph. mat.	118	0
Amsterdam	60	0
Bangkok	24	0
Berbia	35	0
Bombay	441	0
Boston	24	0
Bundaberg	8	0
Buenos Ayres	522	0
„ „ Teleg. mat.	223	0
Calcutta...	250	0
Cape Town	3,528	0
Colombo...	418	0
Copenhagen	110	0
Demerara	20	0
Durban	593	0
East London	537	0
Flushing	11	0
Fremantle	16	0
Gothenburg	19	0
Hiogo	26	0
Hong Kong	12	0
La Plata	38	0
Malaga	23	0
Malta. Teleg. mat. ...	38	0
Melbourne	207	0
„ Teleg. mat. ...	387	0
Passages...	260	0
Penang. Teleg. mat. ...	65	0
Port Elizabeth	2,564	0
Rosario	200	0
„ Teleg. mat. ...	62	0
Rotterdam	12	0
„ Teleg. mat. ...	31	0
Rouen	40	0
St. Petersburg	300	0
Singapore	28	0
Stockholm. Teleg. mat.	1,103	0
Sydney	341	0
Teneriffe. Teleg. mat.	290	0
Trieste. Teleg. mat. ...	220	0
Trinidad	60	0
Yokohama	56	0
Total	£13,367	0

Foreign Goods Transhipped.

	£	s.
Leghorn (electric meters)	43	0
Bangkok (electric wares)	1,550	0

Bankruptcy Proceedings.—At the Huddersfield Bankruptcy Court on 28th ult., before Mr. Registrar Freeman, Christopher Yates Young, of Netheroyd Hill, carrying on business as an electrical engineer at St. George's Square, Huddersfield, passed his examination in bankruptcy.

Books Received.—"Electric Railways and Tramways," by Philip Dawson. Published at the office of *Engineering*.

"Outlines of Physics." An elementary text-book. By E. L. Nichols. Published by Macmillan & Co., Limited, London. Price 7s. 6d.

"A Text-book on the Principles of Physics." Third Edition. By Alfred Daniell, M.A., &c. Published by Macmillan & Co., Limited.

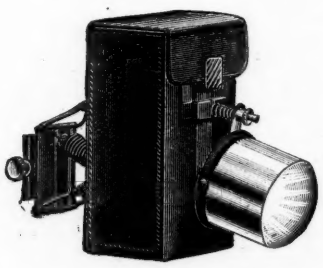
"Physics for Students of Medicine." By Alfred Daniell, M.A., &c. Macmillan & Co., Limited, London. (School class book series).

"Electric Movement in Air and Water with Theoretical Inferences." By Lord Armstrong, C.B., F.R.S. Published by Smith, Elder & Co. Price 30s. net.

Bound Over.—At the Central Criminal Court on Tuesday last, George Fowler, aged 36, who was convicted last sessions of receiving a quantity of stolen electric cable, 37 switches, and other electrical articles, was brought up for sentence. The recorder bound the prisoner over in his own recognisances of £50 to come up for sentence if called upon.

Dissolution of Partnership.—Messrs. C. T. Briscoe and G. H. Shaw, formerly trading as electrical engineers under the style of Briscoe & Shaw, at Central Buildings, Richmond Terrace, Blackburn, have dissolved partnership by mutual consent.

Electric Cycle Lamp.—The lamp illustrated is being supplied by Mr. Archibald J. Wright, 318, Upper Street, N., and comprises a leather case enamelled inside and out with acid-proof enamel, containing a 4-volt accumulator specially designed for obtaining high capacity and durability with minimum size and weight. To the front of case is fixed an electric lantern, with polished bull's-



eye lens, nickelled case and ebonite back, with switch. The lantern has adjustable canting action, so that light can be thrown on the ground immediately in front of machine, or further forward as desired. The back of the case is provided with spring and clip for lamp bracket, as shown. All connections being made inside case, there are no loose external wires. The accumulator is removable for charging. The lamp is made in two sizes to give 8 or 12 hours' light respectively.

Electric Motive Power.—We understand that the Clayton Foundry Company have received the order from Messrs. Lever Bros., of Port Sunlight, to supply two 200-H.P. dynamos to furnish power for wood-working machinery; also for the same firm two motors of the enclosed type of 40-H.P., each to be driven from accumulators for a cross-river barge.

Liquidation Notices.—Creditors of the New Telephone Company, Limited (in liquidation), must send particulars of their debts or claims, and the usual other information to the liquidator, Mr. Albert Anns, 61, Copers Cope Road, Beckenham, Kent, on or before June 15th.

A general meeting of the Electrolytic Research Syndicate will be held at 11, Victoria Street, Westminster, S.W., on July 3rd at 12 o'clock noon, to hear the report of the liquidator, Mr. F. E. Wright, on the winding-up operations.

List.—Messrs. Kinleyside & Co., of Broadgate, Lincoln, have issued a circular dealing with their specialities, including electric bells, small telephone sets, electric clocks, fire alarms, lightning conductors, &c.

New Book.—Messrs. Whittaker & Co. will immediately publish a work on "Organic Chemical Manipulation," on which Dr. J. T. Hewitt, of the East London Technical College, has been engaged. The first part of the text-book will give an account of the methods adopted in organic analysis, and the determinations of molecular weight, the second part being devoted to a typical set of organic preparation systematically arranged, and intended to give an idea of the methods adopted in organic work.

New Premises.—Mr. Samuel Harrison, of Ormskirk Road, Pemberton, Wigan, has taken the Ellesmere Mill, Newtown, Pemberton, in addition to his present premises, to enable him to

cope with increasing business. He is having the new works fitted up with various classes of machinery for more extensive manufacture of the accessories for electric lighting, transmission of power, telephones and bell work.

St. Petersburg Electrical Exhibition, 1899.—The Russian Electro-Technical Association will hold in St. Petersburg, during the summer of 1899, an International Electrical Exhibition, to which, says a financial contemporary, all the principal electro-technical industrial concerns will be invited. At this exhibition all the appliances of modern times and all the effects of electricity will be shown.

Telephone for the Sick Room.—The Private Wire and Telephone Installation Company send us a copy of their 1894 catalogue, which contains a description of their No. D 13 pattern telephone, which is there specified as of great convenience in the sick room. They say that the only difference between the instrument described in our last issue and that illustrated in their 1894 list, is that the latter was introduced three years too soon to secure for it the title "Diamond Jubilee."

The Liverpool Gas and Electric Fittings Company, Limited.—This company write us as follows with reference to statements which have been circulated in various papers to the effect that they have abandoned their electrical department:—1st. The directors did not determine to give up the electrical portion until they were satisfied that they could dispose of it to the new company which is about to be registered. The preliminary agreement for purchase of this company's electrical business having already been completed. 2. The Liverpool Gas and Electric Fittings Company, Limited, never intended to refuse any electrical contracts until the business was finally transferred. 3. The value of the contracts now in hand and transferred to the new syndicate amounts to about £10,000 all of which will show a handsome profit. 4. The company are prepared to tender and accept any contracts until such time as they finally hand over the business to the new company, which is to be styled The Liverpool and Manchester Electrical Company, Limited (nominal capital £30,000). 5. Gas and electricity under the same roof is like mixing sulphuric acid with water, as many amateurs have done to their cost.

ELECTRIC LIGHTING NOTES.

Aberdeen.—A Sub-Committee of the Harbour Board last week further considered the schemes for the electric lighting of the harbour. The report submitted to the Sub-Committee gave details of two alternative schemes—one providing for the current being supplied from the Corporation mains, and the other for an installation to be laid down by the Commissioners. In view of the fact that the resolution of the Town Council to adopt the high pressure system of supply may have an important bearing on the cost of procuring the current from the Corporation mains, it was decided to have an interview with Councillor Johnston, convener of the Gas and Electric Lighting Committee, and Mr. Blackman, electrical engineer, before reporting to the commissioners.

The Gas and Electric Lighting Committee last week considered the question of the proposed electric lighting of the west end of the city. It was resolved that, before taking any steps to carry out the extension, a sub-committee should ascertain the needs of other parts of the city and the cost of providing the electric light there.

Bradford.—The illumination of Forster Square, Bradford, on Jubilee night, will consist of 1,000 electric lights in coloured globes. These will be hung from a pole in the centre, and will be carried in festoons to 20 poles surrounding the square. The centre pole will be surmounted by four large electric globes, and these will be topped by a large illuminated crown.

Bristol.—The Electrical Committee have agreed to supply electricity at half price for the illumination of Corn Street, Wine Street, Broad Street, and High Street, on June 22nd, and they are also going to illuminate the Queen's statue in College Green.

Chepping Wycombe, Bucks.—In the *London Gazette* is filed a notice, signed by the Town Clerk, to the effect that the Urban Sanitary Authority proposes to submit to the Board of Trade for approval a draft deed of transfer of the electric lighting order (1894) to the Wycombe Borough Electric Light and Power Company. The company are to pay the Corporation £300.

Colwyn Bay.—Owing to the small attendance at the last Council meeting, the question of appointing an engineer for the electric lighting and refuse destructor was deferred.

Croydon.—To meet the large and constantly increasing demands for the electric light at Croydon, the Corporation has decided to extend the present plant and stations. The number of lamps connected at present is equivalent to about 6,600 of 8 candle-power, and there are about 4,000 further applications, making a total of 10,600. It is estimated that by December next the number of lamps will be increased to 12,000, and that at the end of 1898 there will be 10,000 more lamps to supply than at the end of the present year. The Council have decided to apply to the Local Government Board for sanction to borrow a further loan of £5,500.

Dundee.—A committee of the Gas Commissioners have been considering the question of introducing a rebate system in connection with the electric lighting.

Edinburgh.—The Council has adopted the recommendation of a committee to increase the salary of the electrical engineer from £400 to £500, and the superintendent of mains from £200 to £240.

A statement has just been prepared by Councillor Mackenzie, convener of the Electric Light Committee, of the income and cost of the electric lighting from May 15th, 1896, to May 15th, 1897. The income from private lighting, at 5d. per unit, and from motor power was:—Summer term, £3,080; winter term, £8,418; spring term, £9,184—together, £20,682—as against an estimated income of £16,500. The income from arc lighting was £6,283, as against an estimated income of £7,250, the difference being caused by the late delivery of the arc lamps for the city extensions. The total income was therefore £26,965, as against an estimate of £23,750, or an excess over estimate of £3,215. The cost of manufacture, distribution, &c., was £19,200, which showed a profit of £7,765. The output was 1,102,700 units sold for private lighting and motor power, and 621,260 for arc lighting—a total of 1,723,960 units. The cost has now been reduced to 4d. per unit, or, with the discount off, practically 3½d. per unit. The cost per arc lamp for public lighting is now £16. "These rates are the lowest charged for electric lighting in the United Kingdom."

Folkestone.—Last Friday's *London Gazette* contains notice, signed by the Town Clerk, to the effect that the Corporation intends submitting to the Board of Trade, for approval, a deed of transfer of the electric lighting order (1896) to the Folkestone Electricity Supply Company, Limited. The transfer is made for 42 years. The company pays the expenses of obtaining and transferring the order to the Corporation. The company's rates for private lighting must not exceed the following rates per quarter:—Up to 20 units 13s. 4d., and for each unit over 20, 7d. The general terms of the transfer are given in the *London Gazette*.

Hampstead.—The Lighting Committee reported to the Vestry last week that they had fully considered the report of Major Cardew on the fatal accident which occurred to an employé of the Vestry; that the chief electrical engineer had been in communication with Major Cardew as to the suggestions made by him in such report; that the measures now being taken by the Committee were such as had been approved by Major Cardew; that the means whereby such measures should be carried out had already, in part, been sanctioned by the Vestry. It was accordingly decided to alter the high tension switchboards, to replace the existing china switches by cam switches, to fit covers to the ten high tension boards, and to adopt a new pattern china fuse with handle.

The tenders for electric wiring at the Central Library have been referred to committee.

Hull.—Last week Councillor Skinner submitted a statement of accounts relating to the electric light undertaking. He said the yearly accounts had been made up to March 31st, but on previous occasions the yearly statement had been prepared on December 31st. This alteration was thought desirable, as the returns required by Government from all other departments of the Corporation had to be made up to March 31st in each year, the electric lighting department alone being closed at the end of December. Consequently the present return embraced a period of 15 months, instead of 12 months, as in previous years. This charge involved the charging of amounts to sinking fund sufficient to cover two years' working within only 15 months. Even after doing this the net profit to be carried to reserve is still £1,931 9s. 10d., whereas, if only 15 months' sinking fund payments had been charged the net profit would have been £1,100 more, or £3,031 altogether. The works had been maintained in an efficient condition, and the works costs of generating current again showed a small decrease. During the year the committee had submitted a scheme for a large extension, and that having received the approval of the Council they only now awaited the approval of the Local Government Board for the borrowing of the necessary capital.

Lambeth.—The plan submitted by the South London Electric Supply Corporation, Limited, proposing to erect their electric lighting station and destructor on about 3 acres of open land immediately north of and adjoining the high level line of the Crystal Palace Railway, between the Loughborough and Denmark Hill stations, has been approved by the Vestry.

The General Purposes Committee reported at the meeting of this Vestry last week that a notice had been submitted by the South London Electric Supply Corporation of their intention to open up and lay mains in certain thoroughfares. The company proposed to lay the mains in earthenware conduits, each system being drawn into a separate duct, and to place the conduits under the footways in every instance, crossing the roadways at right angles. Permission was given conditionally.

Larne.—As there are numerous complaints made of the electric lighting of some of the streets, the Commissioners recently asked the electric light company to estimate for certain alterations and the rearrangement of lamps. The estimate is considered exorbitant, and the Lighting Committee will go fully into the question of street lighting.

London.—The Court of Common Council last week granted an application made by the solicitor of Messrs. Sax for permission to transfer the lease of the buildings in course of erection in Charterhouse Street, and the concession for lighting the Central Markets, to Mr. J. Van den Berg and Sir John Morris.

Liverpool.—Many complaints have been made about the unhealthy condition of Picton Hall, and it is stated that the atmosphere of the Hall when analysed contained an unhealthy percentage of carbonic acid gas, and was calculated to lower the vitality of the healthiest persons. A committee recommends the City Council to light the building by electricity, and instruct the city engineer to draw up a new scheme for ventilation.

The success of the electric lighting installation has been such that the Corporation are considering an expenditure of something like £100,000 upon extensions.

Maritzburg.—Scott's new theatre, Maritzburg, has just been lighted throughout by electricity, Messrs. Siemens Bros. & Co. having supplied the plant, &c., which was put up under the supervision of Mr. C. A. Williams, who went out from England for the purpose. The plant is capable of supplying 460 16-C.P. lamps. There are 86 footlights, and a number of electroliers and other suitable fittings.

Middlesex County Asylum.—The Committee of Visitors of the Middlesex County Asylum at Wandsworth Common, refer in their annual report to the electric lighting now in progress at the annexe and recreation hall of the asylum. The Committee state that the other portions of the asylum will be "wired by the asylum workmen" as opportunities occur, as soon as the present building operations are completed.

Mitchelstown (Ireland).—The question of providing for the electric lighting of the district has been occupying the attention of the Board of Guardians, who propose to enter into an arrangement with Mr. W. D. Webber, landlord of the Kingston estate, for the electric lighting for a stipulated annual sum.

Poplar.—The Board of Works has decided to appoint Mr. Morgan Williams, consulting engineer, at a stated fee, to advise on the subject of putting into force the provisional order, or of transferring the powers to a company.

Reading.—The Reading Electric Supply Company propose to give a continuous supply of current from their central station in the Vastern Road on and after September 1st.

Richmond.—The Town Council have directed their clerk to call the attention of the Richmond Electric Lighting Company to a circular issued by them, in which it is stated that the undertakers are empowered to make a minimum charge of £3 10s. per quarter for current supplied; but they have modified these terms to 11s. 8d. per quarter, this being the equivalent of 20 B.O.T. units at 7d. per unit. The Town Council point out that the company have not the power of making a minimum charge as stated, it being stipulated in Clause 8 of the company's contract with the Town Council that the charge for any quantity up to 100 units should mean at the rate of £3 10s. per 100 units, and so in proportion for any less number of units.

The Town Council have asked the Richmond Electric Light Company to make a small experimental lighting of a part of the borough, with a view of enabling the Council to determine as to the feasibility of lighting the borough with arc lamps. Mr. K. V. Renwick, the secretary to the company, has replied that the cost of such an experiment would be very heavy, amounting to about £30 per lamp, and the company will not therefore undertake the experiment, though they are willing to enter into a contract to supply 20 or more such lamps, standards, &c., for public lighting from dusk to midnight by arc lamps, and from midnight to dawn by two incandescent lamps of 16 C.P. each, at a price of £26 per standard, or, say, £520 for 20 lamps.

Stirling.—The House of Lords' Committee has rejected the Bill proposed by the Police Commission for sanction to purchase the gas works of the town. This is stated to be in consequence of ratepayers' opposition.

Sunderland.—The exterior of the Town Hall is to be illuminated on Jubilee day with incandescent lamps of various colours, to the extent of 8,000 C.P.

Tunbridge Wells.—The Lighting Committee will recommend the Council to increase the salary of Mr. H. L. P. Boot, the electrical engineer, from £250 to £350 per annum.

Weston-super-Mare.—A special committee meeting of the whole of the Urban District Council was held on Monday for the purpose of considering the desirability of utilising the powers contained in the provisional order obtained by the late Local Board, and retained by the Council, for the purposes of an installation of electric lighting for the town. The minutes of the Lighting Committee of May 24th were read, including a letter from "The Imperial Electric Light and Power Company," giving notice that they intended applying in the next session for a provisional order for the electric lighting of the Council's district, and to ask the Board of Trade to revoke the Council's order on the ground that they had failed to carry the same into effect. A letter was also read from Messrs. Capell & Melsome stating that a syndicate had been formed who would forthwith apply for, and if obtained, exercise power for installing the electric light in the town. Before applying to the Board of Trade direct the syndicate would be glad to learn the views of the Council as to whether they would entertain negotiations on the part of the syndicate for the acquisition by them of the powers which the Council had obtained. A telegram was received from the secretary to the Electrical Development and Finance Corporation, stating that the corporation were prepared to carry out electric lighting for Weston-super-Mare for £23,000, and to take a lease of the undertaking on completion from the Council for 10 years, paying progressive rentals of £1,100 for the first year and £50 increase each year public lighting 3d. per unit, private lighting 6d. It was ultimately resolved that an electrical engineer be appointed to confer with a committee of the whole Council as to the best site, system, and plant to adopt, and the probable cost of carrying out the powers contained in the provisional order dated 1891.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Birkenhead.—A special committee, which has been considering the electric tramway question has decided by a bare majority to recommend that the scheme of Mr. Ross, of Birmingham, with certain modifications, be adopted by the Council.

Bray.—At a meeting of the Bray Committee formed to promote the electric railway between the town and Glendalough, held last week, a letter was read from the Newtownmountkennedy Committee requesting the Bray Committee to send some of its members to the meeting to be held at Newtownmountkennedy for the purpose of considering the engineer's report on the best route for the electric line to take to Glendalough. A deputation accordingly attended the meeting.

Bridges Worked Electrically.—Two swing bridges for the improvement of the navigation at Norwich are being made by Messrs. Handyside & Company for the Weaver Trustees. We understand that they are to be operated by electricity.

Brighton and Rottingdean.—The re-constructed car for use on the Rottingdean Electric Railway is now standing at Paston Place Groyne, and is attracting great interest. The repairs and reconstruction have been carried out under the supervision of Mr. Magnus Volk. The new saloon, built of solid teak has been erected by Messrs. Courtney and Birkett at Southwick, and is ready to be put on the deck of the car, which it is hoped will be completed and ready for working by Whitsuntide.

Buenos Ayres.—The *Financial News* says that Buenos Ayres now enjoys electric tramcars. The export department of one of the leading United States electrical companies has, according to its managers, shipped more electrical machinery and apparatus to Buenos Ayres during the last month than in any other previous month in the record of the company. This is said to be due to the activity with which electricity is being used there.

Cardiff.—At the last meeting of the County Council the recommendations of the Electric Tramways Committee were considered. It has been resolved to meet objections which had been raised, by recommending that in the provisional order powers be sought to construct, in addition to the lines previously proposed, one along Albany Road to Newport Road to the end of Broadway, and through Broadway and Clifton Street to the end of Copper Street.

Dover.—The Council decided last week to write to Mr. Sellon, the consulting engineer, to the effect that the work connected with the tramways is not being properly carried out, and asking him to see that it was. Some of the cars have arrived in the town, and a cheque has been drawn in favour of one of the contractors, but this is to be detained until the Mayor is satisfied with the work.

With reference to our last week's note regarding the delay in the construction work on the Dover electric tramways, Messrs. Dick, Kerr & Co., Ltd., inform us that the overhead construction work on these tramways is progressing very satisfactorily; all the poles will be erected this week, and work of stringing the trolley wire will be commenced next week. This work is in Messrs. Dick, Kerr and Co.'s hands, and they state would have been completed had it not been delayed by the permanent way construction which is in other hands.

Dublin to Clontarf.—On this, the second electric tramline in the Dublin suburbs, the poles for the overhead trolley system have been erected all the way from Annesley Bridge to Clontarf, while the necessary bonding of the rails for electric purposes over the whole distance has also been completed. The power factory at Clontarf will be ready for the necessary machinery within a week. The directors expect to be in a position to commence working the line toward the end of July.

Excess Current Recorder.—In a recent issue we noted the introduction, upon the electric traction field, of a new device brought out by Mr. J. A. Cravath for showing differences in operating electric tramcars, by means of a long thin strip, up which a bare wire (carrying the motor current) eats or rather burns its way whenever an excessive amount of current is used. The *Street Railway Review* illustrates in its last issue a couple of such strips after use, alongside a new strip. The changes, even in a single strip, between the currents used at different times and presumably by different motormen is very marked. Our contemporary calls attention to a "rather curious phenomenon" in the shape of notches left in the groove where the wire has paused between intervals of using heavy currents. Obviously this is due to the fact of the wire always carrying current while the car moves, and therefore always being slightly heated, enough to gradually melt the surrounding alloy, but perhaps hardly enough to overcome the co-efficient of "sticktion" in the apparatus. It will be remembered that the device is intended to act as a check upon the motormen, since it shows which of them is wasting current unnecessarily at starting and stopping, as well as when running.

Electric Launch.—On 19th ult., there was launched from the yard of Mr. W. S. Sargeant, Strand on the Green, Chiswick, an electric launch, the *Volta*, built to the order of the Chester Boat Company, Limited, Chester. The boat is 25 feet 6 inches long with 5 feet 8 inch beam, and 2 feet 9 inches depth, and the draught of water is 1 foot 6 inches. There are 28 cells of the Faure-King traction type, 150 ampere-hours capacity, transmitting power to the motor (which was manufactured by the builder), which is placed aft, under the floor, and coupled up direct to the propeller shaft. The propeller rotates at 650 revolutions per minute. The armature is wound for a tension of 56 volts, and discharging, when running at full speed, 13·5 amperes, practically absorbing 754 watts and giving about 5 miles mean speed through the water, which can be increased to about 7 miles per hour. The boat will give, absorbing the above mentioned watt power, a run of about 11 hours with one charge. The switch, which is under the control of the steersman aft, gives two speeds ahead and two speeds astern, and is worked with one lever, which is Mr. Sargeant's own practical improvement and manufacture. The cells are connected up in parallel and series to port and starboard field, and port and starboard armature. The displacement of the launch is 35 cwt. when running with one man on board. The *Volta* was put upon her trial trip of a run of 12 miles without stoppings. This is the first of a series of electric launches to be placed upon the Dee. The charging current is supplied by the Chester Corporation at the Boat Company's premises which will be the head charging station for electric launches on the River Dee.

Finsbury Park and Moorgate Street Underground Scheme.—The application of the promoters of this line which, it will be remembered, was offered to the public a year or two ago, for an extension of the time for the acquisition of land and the completion of the works from June 1900 to June 1902, came before a select committee on Monday. Mr. Pember, Q.C., explained that it was also proposed by the present Bill to increase the capital of the company by £60,000 in shares and £20,000 loan; to divide the shares into two classes, preferred and deferred; and to sanction the partial substitution of brick or other material for lining the tunnels in lieu of iron or other metal. The tunnels would be 16 feet in diameter, and the gauge would be the same as the Great Northern, so that the railway would be available for the trains of the latter company, and passengers could pass from one system to the other without change of carriages. In 1895 the public were invited to subscribe £1,000,000 to carry out the undertaking. Independent applications were received for shares to the value of over £400,000; the contractor had undertaken to take another £240,000 worth; and there would probably have been no difficulty in getting the balance of the amount required underwritten had it not been for the death of the contractor, Mr. Willans. Since then Sir Weetman Pearson, M.P., the constructor of the Blackwall Tunnel, had agreed to take the contract, and there was no longer any doubt that the line would be absolutely proceeded with. The only opposition to the Bill came from the Great Northern Railway company, who objected to being bound by their agreement if there was to be an extension of time. Sir W. Pearson, M.P., said he had carefully calculated the probable revenues to be derived from the railway, and he had come to the conclusion that the scheme would unquestionably be a profitable one. He was prepared, therefore, to take, as part of his contract, the whole of the deferred shares—that is, about £750,000. That would leave a similar amount to be raised on preference shares. It was agreed that a clause should be inserted in the Bill to the effect that the agreement with the Great Northern Company should become null and void unless by June, 1900, it should be proved to the satisfaction of the Board of Trade that satisfactory progress was being made with the construction of the line. The Bill was amended accordingly, and the preamble declared proved.

Isle of Thanet.—The promoters of the electric railway have abandoned the Westgate line and agreed not to construct the Pegwell line for two years as the Commission refuses to sanction the taking up of the sea front lines when once made. The promoters offer not to construct sea front lines until the consent of the Margate Town Council be obtained.

At a meeting of the Town Council at Ramsgate last week the light railway scheme was again discussed, and it was resolved: "That the resolution passed by the Council on May 6th adopting the report of the committee of the whole Council of May 3rd relating to the light railway proposed to be constructed in the Isle of Thanet be rescinded, and that the whole subject be reconsidered."

Liverpool.—The Committee of the Liverpool Corporation entrusted with the working of the Tramways, have requested Mr. H. Graham Harris, of the firm of Messrs. Bramwell and Harris, to report generally upon the tramways, and upon the best mode of traction to be adopted by them. They have also requested an American engineer and a Canadian engineer—Mr. Pearson and Mr. Cunninghame—to report upon the question.

Manchester.—Some correspondence has taken place between the Manchester Carriage and Tramways Company and the Town Clerk of Manchester with reference to a re-lease of the tramways. The company is desirous, says a London daily, of a re-lease to itself, and suggested through its solicitors, that the question of terms should be referred to the Secretary of the Board of Trade, the corporation on the one hand and the company on the other laying a statement before him. The special committee of the corporation, having considered the suggestion, declined to entertain it. The Town Clerk was instructed to reply:—"The Manchester Corporation is of opinion that the working of tramways should be permissible to the local authorities owning the same, and that such authorities should have unrestricted discretion either to work the tramways themselves or to lease them, and it is on this principle and with this object in view that this corporation is making application to Parliament in the present session."

Neath.—Tenders of rental are at present being invited by the Neath Corporation for the working by horse or mechanical traction of the existing line of tramways about to be reconstructed by the Corporation, extending from Skewen to Briton Ferry, through the market town of Neath, a distance of about 4½ miles, and serving a population of about 30,000. Lease, 7, 14, or 21 years. Plans, &c., from the borough engineer, Mr. D. M. Jenkins, Gwyn Hall, Neath.

Norwich.—The Select Committee of the House of Commons held its first sitting to consider the above electric tramway Bill on Monday last.

Swansea.—At a meeting of the Parliamentary Committee of the Swansea Corporation on Monday the Bill promoted by the Tramways Company with the object of obtaining powers for raising fresh capital and equipping the system with electricity was discussed, and it was decided to take such steps as are necessary to secure a *locus standi* when the Bill comes before the Commons' Committee in order that clauses protective of the burgesses' interests may be introduced.

Whitechapel to Bow.—A financial contemporary learns that the promoters of the Whitechapel and Bow Railway scheme have concluded settlements with all the opponents who threatened opposition to this railway before the Select Committee of the House of Commons to which it was referred. The Bill, which will now pass as an unopposed measure through the first House, provides for the incorporation of a new company for the purpose of constructing a railway from junctions with the Metropolitan and Metropolitan District Railways at Whitechapel to a junction with the London, Tilbury and Southend Railway in the parish of St. Leonard, Bromley. The estimated cost of constructing this railway is £672,500.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec. 19th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Jamaica-Colon	Feb. 6th, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Para-Maranham	May 5th, 1897 ...	June 1st, 1897.
Assab-Massowah	May 21st, 1897 ...	May 28th, 1897.
Lourenço-Marques	May 29th, 1897 ...	...
Grenada-Trinidad	June 2nd, 1897 ...	...
Landlines.		
Trans-Continental line beyond Mazol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Moulmein-Bangkok	May 5th, 1897 ...	May 6th, 1897.
Siberian Lines:—		
Nertschinsk-Stretinsk ...	May 29th, 1897 ...	May 30th, 1897.
Werkhne-Oudinsk-Tchita	June 1st, 1897 ...	...

April 19th, 1897.—Chio-Syra route impracticable.

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announces that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be in plain language.

April 21st, 1897.—The Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—The Hellenic Administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

May 26th, 1897.—The Ottoman Administration notifies that, until further notice, private telegrams for Crete must be written in plain Turkish or French language.

During the interruption of communication with Trinidad and Demerara telegrams are sent by hired boat. Delay about 24 hours.

Coast Communication.—In the Commons last Friday the following discussion arose on the Civil Service Supply Estimates:—Captain Bethell (York, E.R., Holderness) asked whether the Board of Trade had nearly completed the communication between one lighthouse and another and the stations on the mainland, and whether electric communication with the light-ships had been satisfactorily effected.—Mr. T. G. Bowles asked for some information with regard to the electric communication with lighthouses, how far the system had gone, and what was to be effected in the ensuing year.—Capt. Pirie also referred to the establishment of electric communication between the lighthouses and the mainland. This experiment had now been going on for upwards of four years, and they had by no means reached finality. Every expert who had considered the subject, and the report of the Commissioners, had shown that the experiment was most unsatisfactory and had led to no good result. The money would be better used to increase the number of lighthouses or fog signals so as to prevent accidents than in useless

attempts to establish communication between the lighthouses and the mainland. The money spent on communication between lighthouses and the shore should be made to go as far as possible, especially as regarded Scotland. The Scotch coasts were notably deficient in lighthouses and fog signals. The secretary of Lloyd's, writing to the Plymouth Chamber of Commerce, stated that the experience of Lloyd's proved that the best means of diminishing loss of life round the coasts was the establishment of lighthouses and fog signals, which prevented casualties, rather than of telegraphic installations which only availed after a casualty had taken place. Merchant shipping increased round the coasts of Scotland, and especially the north coast, every year. At present there was no fog signal between the Atlantic and Aberdeen. He moved to reduce the vote.—Mr. Ritchie said he understood the hon. member to advocate that all means of electrical communication between light-ships and the shore, for the purpose of signalling, should be abolished. His argument that the money should be spent on lighthouses was one that the Committee should not consider. If more lighthouses were wanted they should be provided, but the question whether electrical communication was good or bad must stand by itself, apart from whether more lighthouses were wanted. The Royal Commission of 1892 recommended a large number of electrical communications on our coasts, which had since been completed, and other recommendations would be carried out without delay.—Mr. T. G. Bowles said he could not understand that anyone who knew the situation in which lighthouses and light-ships were should desire that they should be cut off from communication with the land. In the outlying sands on the east coast of England it would be the salvation of thousands of lives a year, if there was electrical communication with the light-ships. He suggested that the President of the Board of Trade might inform himself as to the interesting experiments which had been initiated by an Italian scientist for transmitting electricity without wires or apparatus along waves of ether. That was a direction in which some money might well be spent in the hope of avoiding prospective expenditure hereafter. He trusted the hon. and gallant member would not persist in his proposal to give up the attempt to establish most necessary and useful communication between light-ships and the shore.—Captain Pirie remarked that if the Government would give an assurance that they intended to strike out fresh lines and investigate the recent discovery of Marconi, he would be delighted to withdraw his amendment.—Mr. Ritchie mentioned that £600 of the money asked for in the vote was for experiments in connection with the system of communicating through space.

French Cable Expansion.—The *Science Francaise*, referring to the approaching establishment of a new trans-Atlantic cable between France and the United States, says that the French transport *Drôme* has been apportioned the important work of sounding operations between Brest and the American coast for the purpose of securing the best bed for a cable. The length estimated is 6,000 kilometres, and the new cable will double the existing communication between France and the United States.

Guernsey Telephones.—Major-General F. B. Mainguy, chairman of the Guernsey Telephone Committee, informs a daily paper that general satisfaction is expressed in the island at the news that the Treasury has decided to allow the inhabitants to carry on their own telephone service.

CONTRACTS OPEN AND CLOSED.

OPEN.

Battersea.—The Vestry has accepted the tender of the General Electric Company for the supply of 500 incandescent lamps for stock, at 11½d. each.

Bedford.—June 8th. The Urban Sanitary Authority want tenders for the supply and erection at the sewage pumping works of two alternating current motors coupled direct to two vertical spindle centrifugal pumps.

Belgium.—July 2nd. Tenders are being invited until July 2nd next, by the Municipal Authorities of Ghent, for the establishment of an electric tramway in the town. Particulars may be had from the Secretariat, while tenders are to be sent to Le Collège Echivinal, Ghent.

Blackpool.—June 18th. The Corporation invite tenders for the supply, up to March 31st, 1898, of about 60,000 carbons of various measurements, &c. Borough Electrical Engineer, Mr. R. C. Quin. See our "Official Notices" for further particulars.

Blackpool. — June 21st. The Corporation Electric Lighting and Tramways Committee want tenders for the supply of two bogie tramcars. Particulars from Mr. J. Lancaster, Manager, Tramways Depôt, Blundell Street, Blackpool.

Bray.—June 7th. The Township Commissioners want tenders for the supply of electrical and other stores, including carbons, cables, switches, lamps, holders, fuses, &c., during twelve months. Particulars from the Town Clerk (Mr. P. MacDonnell), at the Town Hall.

Brazil.—June 30th. Tenders are being invited until June 30th next by the Municipal Authorities of Rio de Janeiro for the establishment of a telephone exchange in the city. Particulars of the contract were published in *Daily Tenders and Contracts* for May 6th.

Brighton.—June 14th. Tenders are wanted for the completion of the electric light wiring, &c., of the Municipal School of Science and Technology, Richmond Terrace, Brighton, for the Council. Particulars obtained at the office of Mr. Francis J. Tillstone, Town Clerk, Town Hall, Brighton.

Chili.—June 19th. The General Direction of the Chilian Telegraphs in Santiago is inviting tenders for the supply of a quantity of galvanised iron wire, insulators, Morse telegraph apparatus, &c.

Denbigh.—June 12th. Tenders are invited for the supply of complete electric light installation, for the North Wales Counties Asylum, Denbigh, including engine, dynamo, batteries and wiring, for lighting new temporary buildings at the Asylum. Particulars from the Clerk to the Visitors, or Mr. Thos. L. Miller, M.I.C.E., 7, Tower Buildings, Water Street, Liverpool.

France.—June 23rd. Tenders are being invited until June 23rd, by the Prefectural Authorities of the Rhône at Lyons, for an installation of electric lighting in the Bron Asile d'Aliénés. Tenders to be sent to the Préfécture du Rhône, Lyons.

Glasgow.—June 7th. Tenders are being invited by the Corporation for the supply of battery regulators and armoured cables for street mains. Particulars from Mr. William Arnot, electrical engineer.

Halifax.—June 21st. The Corporation want tenders for the supply of generators and motor generators, accumulators, and electrical equipment of cars for the proposed electric tramways. Borough Electrical Engineer, Mr. T. P. Wilmshurst. See our "Official Notices."

Handsworth (Staffs.).—June 7th. The District Council want tenders for the supply and fixing of electrical plant and apparatus for lighting the council house, public library, the new technical school and other buildings. Labour clause. Particulars from the Clerk of Works, New Technical School, Stafford Road, Handsworth.

Neath.—June 28th. The Neath Corporation are inviting tenders for the working, by horse or mechanical traction, of the existing line of tramways. See our "Traction Notes."

Roumania.—August 20th. Tenders are being invited by the General Direction of the Roumanian Posts and Telegraphs in Bucharest for the supply of 55,000 porcelain (double-bell) insulators. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Bucharest.

Southampton.—June 16th. The Corporation wants tenders for the supply and erection of water-tube boilers, mechanical stokers, coal conveyor, pump, steam and water mains, water tank, water purifier, fuel economiser, and ironwork. Engineers, Messrs. Kincaid, Waller & Manville.

Spain.—June 8th. The Spanish Ministry of Public Works in Madrid is inviting tenders for the concession for a projected electric tramway between Barcelona and its suburbs. Tenders to the Direccion Generale des Obras Publicas, Madrid.

Sweden.—June 8th. Tenders are being invited by the Stockholm Gas Works Authorities for the supply and erection of a 500 H.P. triple-expansion engine required in connection with the central electric lighting station. Tenders to be addressed to the chief engineer, Herr Ad. Ahlsell, Stockholm Gaswerk, Stockholm.

Sydney (New South Wales).—Tenders are wanted for four duplicate sets of engines and dynamos capable of running 2,000, 4,000 and 5,000 lights each, landed and erected in Sydney. These are required for lighting a large block of buildings, including the Hotel Agincourt, that have been erected for Mr. Henry Goodwin, who is now staying at Anderton's Hotel, Fleet Street, London, E.C. Particulars can be obtained from Mr. Goodwin at that address.

CLOSED.

Dundee.—The Gas Committee, after considering the tenders for new engine, dynamos, new boiler, arc lamps and accessories, and a new battery, recommend the acceptance of the offer of Messrs. Siemens Brothers, of £1,505, for the engine and dynamo; Messrs. Cooper & Greig, Dundee, £493, for the boiler; and the Crompton Company, £332 4s. for the arc lamps and accessories. With regard to the proposed purchase of a battery, it was resolved to ask the contractor to take back the old battery and to have two new ones introduced. On that footing the offer of the Electrical Power Storage Company, Limited, London, amounting to £1,012 is to be accepted.

France.—The General Direction of the French Post and Telegraphs has just divided a contract for 21 kilometres of paper-insulated telegraph cables between Messrs. Aboilard & Co. (46, Avenue de Bretueil), Paris, and M. A. Grammont, Pont-de-Cheruy (Isère).

Southend.—We are informed that the tender of Messrs. Middleton, at £12,500, has been accepted for electric lighting appliances for the Hotel Metropole, Southend-on-Sea.

NEW ELECTRIC LIGHTING STATION FOR SOUTHAMPTON.

About a year ago the Corporation acquired the property of the Southampton Electric Light Company, as it was generally felt that such an undertaking should be under the control of the Municipal authorities. Soon after the works had been taken possession of, advice was sought with the idea of extending the mains throughout the borough, and one of the most important steps in this direction was the provision of a new electric lighting station, the foundation stone of the building being laid by the Mayor (Mr. E. Gayton) on Tuesday, alongside the existing works, at the Back-of-the-Walls.

At the commencement of the ceremony Mr. Manville, of Messrs. Kincaid, Waller & Manville, the electrical engineers to the Corporation, stated that for many years past good work in the way of electric lighting had been carried out in the temporary building they saw at the back of them, and the time had about come when the whole undertaking required to be put on a more substantial and permanent basis. In order to do that the Corporation were erecting buildings of an adequate kind, and of amply sufficient dimensions not only to accommodate the machinery to be installed there, in addition to the existing machinery, but to allow of considerable extension in the future.

At the conclusion of the proceedings, which were very brief, the company adjourned to the Pavilion on the Royal Pier for luncheon.

In submitting the toast "Success to the Corporation Electric Supply," the Mayor said he remembered the time—not very long ago—when the undertaking could have been purchased for £750, but the corporators in those days were not wise men, and they refused the offer, and some months ago they paid something like £23,000 to have the undertaking in their sole and entire control. Whether this was a wise step or not he thought future events would show, and prove conclusively that even though they had had to pay something like £23,000 it at that period was a paying concern. He thought that the Corporation had done rightly in acquiring that property, because he believed it would be as time went on—and as Alderman Bone would be able to prove—one of the greatest benefits and boons to the inhabitants of the town, because the profit would go in a large measure to reduce the rates of the town.

Alderman Bone, Chairman of the Electric Light Committee, gave the following interesting facts in connection with the introduction of electric lighting into Southampton.

In the year 1889 the Corporation, having neglected to apply for an order or license, a few public spirited men applied for a license to Parliament to introduce the electric light. A very short time after they offered their license to the Corporation for the sum of £750. Mr. Lemon brought forward a motion in the Council that they should purchase the license from the company and carry out the works themselves. Time went on, and during the latter part of the year 1895 or 1896 Mr. Lemon, the chairman of the Works Committee, again brought forward the matter in the Council. Several discussions took place, and it was eventually decided to negotiate for the purchase of the works, and they agreed to purchase for the sum of £21,000. He would take the opportunity of saying that the directors of the company met them in the most fair and liberal spirit. They had borne the brunt of the day, and had brought the works to the perfection in which they were, so that it was becoming a profitable concern; but they were public-spirited enough to say that the works should be theirs if they were given the capital expended, with the addition of £800 or £900. They also acquired the property for £5,500, and £1,000 for a little cottage, making £27,600, which was the amount of capital they had invested in their works at the present moment. During the past 12 months, that was from March, 1896, to March, 1897, their receipts had been £3,491, and their working expenses including the six months' working expenses they paid to the company, because they only had them in their own working six months, and including something for the directors' fees, to which they were entitled, were only £2,016, so that they netted a gross profit during the 12 months of £1,475. These were accountants' figures, and were to be relied upon. Out of that £1,475 they had paid interest on borrowed capital, £924, thus leaving a profit, after paying interest, of £551. They had repaid capital, £508, leaving a balance in hand of £42. Therefore they had in the past 12 months the sum of £508 invested in the electric light property for the benefit of the ratepayers of Southampton. He might say, therefore, that they had just cause to be proud of what they had done. They had also reduced the charge for motive power and the light, and there was a rebate in certain cases. They had increased their district main something like three-quarters of a mile, and taken it down Oxford Street, Bernard Street, and Bugle Street, and they were exceedingly well-satisfied with the way residents had taken the current for their lighting. They also had 30 more consumers during the time he referred to, and they looked forward to having a larger number. Although he could not hold out the hope that they would make a corresponding profit next year, because they would have to pay interest and repayment of capital on what was unremunerative in the course of rebuilding, but after that no doubt they would make sufficient to pay the loss of the next 12 months off, and in future years to make as much, if not more, profit than the Mayor had told them had been made by the waterworks during the past 12 months. They were fortunate in having as engineers gentlemen of such eminence in their profession. They were fortunate in having as contractors Messrs. Playfair & Toole, who had carried out large works for the Corporation, and he hoped they would complete the work in the time, which was six months from the commencement. They took over the staff from the company, and he was bound to say of their electrical engineer (Mr. Lee) they had one who was doing his best to make it a profitable concern, and all under him were doing the same.

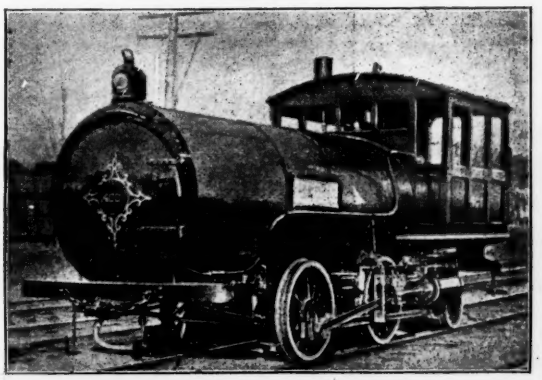
We feel perfectly safe in prophesying that the hopes of the Mayor and Mr. Alderman Bone will be more than fulfilled. With Mr. Manville to direct, with Mr. Lee, an able engineer, to carry out the details of the installation, and with Mr. Gayton and his colleagues to give their enthusiastic and energetic support to the undertaking, the central station of Southampton should be one of the most successful in the kingdom, and the faith of those public spirited men who eight years ago promoted the scheme will assuredly be shown in the near future to have been amply justified.

With electric traction on the tramways added, Southampton will be in a fair way of becoming, as the Mayor expressed it, the front door of England, and regaining that prosperity which but a few years ago seemed to have left it for ever, and its inhabitants may be congratulated in having for the Jubilee year a Mayor and Council so fully alive to the benefits which the extended employment of electricity will bring to the town.

NOTES.

Electric Driving—The Polyphase System.—The *Steamship* says that Messrs. Thos. Richardson & Sons, Limited, the well-known engineers at Hartlepool, have commenced as an adjunct to their marine business the manufacture of electrical power plant in conjunction with Messrs. Brown, Boveri & Co., of Baden, and that they are completing an installation of 1,100 horse-power on the polyphase system for electrically driving their own works. This installation consists of two three-phase generators of the fly-wheel type, driven by two compound Corliss engines, steam being supplied by two large return tube boilers working at 150 lbs. pressure. Messrs. Richardson have engaged the services of Mr. C. F. Higgins, lately chief electrical engineer to Messrs. Brown, Boveri & Co., who will manage the electrical department of their business; and have also obtained a license to manufacture under the patents of Nikola Tesla.

The Hardie Compressed Air Locomotive.—Compressed air is to be tried on the Manhattan elevated line, and we illustrate one of the Hardie locomotives to be used. The illustration has appeared in several trans-Atlantic journals, and the *Street Railway Review* gives a few details regarding its construction. In general appearance the machine much resembles the ordinary steam locomotive. The space usually occupied by the boiler, however, is taken up by the storage tanks for the air and by the reheater. On this locomotive the air is stored in 36 tubes of Mannesmann rolled steel; they are 9 inches in diameter and of varying lengths, from 13½ to 21 feet. The charging pressure is 2,000 lbs. per



square inch. The air is led from these tanks through the reheater, in which water is stored at an initial temperature of 350° F., and after passing through three reducing valves is admitted to the cylinders at a pressure of 150 lbs. The working cylinders are 13½ × 20 inches. The American Air Power Company, which controls the Hardie patents, has erected a compressing plant for charging at 100 Greenwich Street. It is expected that this locomotive will haul five cars and make a run of 13 miles between charges.

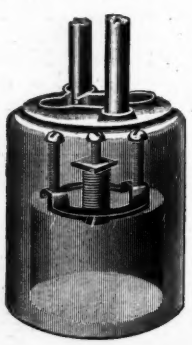
The Institution Secretaryship.—Mr. Walter G. McMillan, F.I.C., F.C.S., lecturer on metallurgy at Mason's College, Birmingham, has been elected to fill the appointment of secretary and librarian of the Institution of Electrical Engineers on the retirement of Mr. F. H. Webb, and he will enter on his duties during the latter part of the year.

American Conventions.—Several of the American engineering societies have, during the past few days, been holding their annual meetings. The American Society of Mechanical Engineers met at Hartford from May 25th to 28th, and among the papers read were the following:—"New Form of Transmission Dynamometer," Fredk. A. Bedell; "Electricity *v.* Shafting in the Machine Shop," Chas. H. Benjamin; "Electrical Power Equipment for General Factory Purposes," D. C. Jackson; "On Rating Electrical Power Plants Upon the Heat-Unit Standard," W. S. Aldrich; "Tests of Sulzer Engines," H. A. Hill; "Tests to Show the Influence of Moisture in Steam on the Economy of a Steam Turbine," D. S. Jacobus.

The Canadian Electrical Association commenced its annual convention at Niagara Falls on Wednesday, June 2nd, the meetings to last until to-day. The following papers were read:—"Day Loads for Central Stations and How to Increase Them," J. A. Kammerer, Toronto; "Submarine Cables—Dealing More Especially with the Actual Experience in Cable Laying and Maintenance in This Country," D. H. Keeley, Ottawa; "Determination of the Heating Power and Steam-producing Value of Coal from a Preliminary Examination," William Thompson, Montreal; "Water-driven Plants," John Murphy, Ottawa; "The Commercial Aspect of Electric Railways," C. E. A. Carr, London, Ont.; "Accumulators: Their Application to Central Station Lighting and Power," W. A. Johnson, Toronto; "Why Some Lighting Plants Do Not Pay," F. C. Armstrong, Toronto; "Steam End of an Electric Plant," A. M. Wickens, Toronto.

The National Electric Light Association commences its three days' conference at Niagara Falls on June 8th.

New Waterproof Socket.—A waterproof lamp socket finds, says the *Electrical World*, very extensive use, as there are many damp and wet situations where electric lamps are taken and used. There are many such sockets in the market, but the one illustrated herewith possesses some advantages ver others of this class. The Bryant Electric Company, Bridgeport, Conn., calls our attention to the important



feature of this device as represented in the method of sealing in the wires, which renders the socket absolutely waterproof. Another important advantage is the length of the porcelain skirt at the bottom. Being of unusual length it fully covers the lamp base. This style of socket is made for Thomson-Houston and Westinghouse bases, and is about to be placed upon the market by the Bryant Electric Company.

Water-Power in Ireland.—The Bill introduced by Mr. Healy, and which was stated to be framed for the purpose of giving compulsory powers for acquiring the right of impounding water both for supplying direct motive power, and where thought advisable, generating electricity, was withdrawn when its second reading was before the House.

The Royal Society.—After the election of Fellows yesterday afternoon, the following paper among others was read:—Prof. Fleming, F.R.S., and Prof. Dewar, F.R.S. (1) On the Dielectric Constants of certain Frozen Electrolytes at and above the Temperature of Liquid Air; (2) On the Dielectric Constants of Pure Ice, Glycerine, Nitrobenzol, and Ethylene Dibromide at and above the Temperature of Liquid Air.

Appointment.—The Leeds Electric Works Committee has gone into the question of the appointment of chief electrical engineer in connection with the electric tramways, and has decided to recommend the appointment of Mr. J. Burbridge, who was manager for a time of the Roundhay electrical tramway, under the Thomson-Houston Company, and who is at present superintending the construction of the new electrical lines in the city. The salary is £300 a year.

The Municipal Electrical Association.—The second annual convention of this Association will be held at Manchester on June 30th, July 1st, 2nd and 3rd. We have received a copy of the provisional programme. The presidential address will be delivered by Mr. C. H. Wordingham, and among the papers to be read and discussed are the following:—

June 30th—"The Generation of Steam." Two papers by J. F. C. Snell, borough electrical engineer, Sunderland; J. J. Steinitz, borough electrical engineer, West Ham.

"Municipal Aids to Wiring," by A. H. Gibbings, borough electrical engineer, Bradford.

Reception by the Electric Lighting Committee of the Corporation of Manchester at the Dickinson Street Works. Inspection of generating station and sub-station. The following works may be visited: S. Z. de Ferranti, Limited, Oldham; Mather & Platt, Salford; Galloways, Limited, Ardwick; Hans Renold & Co., Manchester.

The Association dinner will be held at the Grand Hotel at 7.30 p.m.

July 1st:—"Street Lighting by Electricity." Three papers by H. L. P. Boot, borough electrical engineer, Tunbridge Wells; C. D. Taite, borough electrical engineer, Southport; S. E. Fedden, electricity mains superintendent, Edinburgh.

"Electricity Meters," by T. P. Wilmshurst, borough electrical engineer, Halifax.

"Prepayment Meters," by H. W. Couzens, borough electrical engineer, Taunton.

Visit to Liverpool, and reception by Electric Lighting Committee of the Liverpool Corporation. The following works may be visited: Liverpool Overhead Electric Railway; British Insulated Wire Company, Prescot.

July 2nd—"Distributing Systems." Two papers by J. A. Jeckell, borough electrical engineer, South Shields; J. R. Blaikie, chief assistant electrical engineer, Bristol.

"Localisation of Faults," by R. C. Quin, borough electrical engineer, Blackpool.

Visit to Bradford, and reception by the Electric Lighting Committee. Visit to Halifax and Huddersfield. Reception by the Electric Lighting Committee of Halifax and Huddersfield.

July 3rd—Business meeting for Members and Associates of the Association only, 10.0 a.m., at Manchester Electricity Works, Dickinson Street. Election of president, vice-presidents, two members of committee, secretary, treasurer, and place of meeting for the Convention of 1898. General business. Arrangements have been made for members of the Association and visitors to inspect the Blackpool Corporation Electric Lighting Works, the Blackpool Corporation Electric Tramways, the Southport Corporation Electric Lighting Works, and the Isle of Man Electric Tramway.

Copies of papers to be discussed, and any further information, may be obtained from the hon. secretary, Mr. A. B. Mountain, electric supply station, Huddersfield.

Higher Voltage.—In the Commons on Tuesday, Mr. H. M. Stanley, in the absence of Mr. Burdett-Coutts (Westminster), asked the President of the Board of Trade whether the notice recently issued by the Kensington and Knightsbridge Electric Lighting Company to their consumers, intimating their intention to increase the voltage of the current supplied from 100 to 200, and calling upon the consumers to adapt their fittings at their own expense to comply with the altered voltage, was issued with the sanction of the Board of Trade; and whether compliance with such notice was legally binding on the consumers. Mr. Ritchie said that the sanction of the Board of Trade to any such notice is not required. Under the Board of Trade regulations, any change of standard pressure by the Kensington and Knightsbridge Electric Lighting Company is subject to the approval of the County Council, and not of the Board of Trade. No provision is made for a reference to the Board of Trade, except on appeal by the company against any decision of the County Council. No change is allowable in the pressure of the supply to any premises which on March 4th, 1896, the date of the Board of Trade regulations, were supplied with energy by the company, except with the consent of the consumer.

Appointments Vacant.—The Shoreditch Vestry invite applications for the posts of superintendent of mains and electrician-in-charge, for the electric light installations. See our "Official Notices."

Water Power Plants.—For the advance proof of an article on "The Limitations of Government in Water Power Plants" on page 799, we are indebted to the Replogle Governor Works of Akron, Ohio. We think it may be of sufficient interest to many of our readers to warrant a place in our columns. One of the difficulties encountered by the company is the vague idea that power storage in the shape of fly-wheels is quite unnecessary in regulation of speed of water-wheels. It is a rare thing to find an old water power plant that has any such provision. Imagine all the stationary engines of the country stripped of their fly-wheels, and the engineers required to furnish regular speed for varying loads. That is often substantially the problem before the maker of water-wheel governors; but the use of water power for electrical purposes has brought the question of close regulation to the front, and every hydraulic engineer, every maker of water-wheels, and every user of water-wheels for electric work is keenly alive to the difficulties of the problem and its solution.

The Cable Steamer "John Pender."—Lloyds reported on June 2nd as follows :—

John Pender (s), in entering port to anchor in the dark, grounded on a shoal off Reuben Point. Steamer is apparently on soft bottom, and is making no water. Her Majesty's ship *Magpie* was to make an attempt to tow her off, and every hope was entertained of getting the vessel afloat. (Telegraphed from Lorenzo Marques).

It will be remembered that the Lorenzo Marques and Durban cable was interrupted on May 29th.

Benn v. Electric and General Investment Company.—This case, which was heard by Mr. Justice Bruce and a jury on Wednesday and Thursday, was a claim by Chas. E. Benn, a financial agent, to recover £10,000 damages for alleged breach of contract. We shall give an account next week. Judgment was given for the defendants, with costs.

The Liquefaction of Fluorine Gas.—At the Academy of Sciences in Paris on May 31st, M. Moissan communicated the results of his experiments with Prof. Dewar in the liquefaction of fluorine gas. This gas, as is well known, has hitherto resisted all efforts to reduce it to a liquid state. M. Moissan announced, says the *Times* Paris correspondent, that it had now been liquefied by him and Prof. Dewar at about 185° C. below zero. The experiments resulting in liquefaction were conducted in the famous glass apparatus invented by Prof. Dewar. When a current of fluorine gas is passed into an apparatus maintained in the midst of liquid oxygen in tranquil ebullition at a temperature of *minus* 180° C., liquefaction does not occur. But as soon as that temperature is diminished by exhausting the gas above the liquid oxygen, the liquefaction of the fluorine begins, and a clear yellow and extremely mobile liquid is obtained, which resumes the gaseous state as soon as the temperature rises. This liquid has lost the chemical activity characteristic of fluorine in a state of gas. It no longer attacks glass, silicon, sulphur, or phosphorus. Fluorine at a very low temperature, however, still attacks carburetted hydrogen, and its affinity for hydrogen seems still to exist. M. Moissan and Prof. Dewar are continuing their investigations, and although solid fluorine has not yet been obtained, M. Moissan is sanguine that, with the help of Prof. Dewar, this astonishing result will also be secured. M. Moissan's communication excited the liveliest interest.

The "Engineer" Motor Car Competition.—The *Pall Mall Gazette* says :—So, after all, the much-talked-of motor car competition from London to Birmingham has been abandoned. From a statement issued by the judges, it appears that the cars exhibited were such that they did not feel justified in awarding a prize to any of the exhibitors, and therefore it was not necessary for the trial run to Birmingham to take place. This, we think, is a very right and proper decision, as not one of the seven cars on exhibition was entitled to a prize of such a value as £1,000. If anything the exhibition was even more disappointing than that held in September of last year.

The Submarine Telegraph Memorial.—A meeting of the executive was held yesterday, and was to be followed by an inspection of the bust of Sir John Pender at Mr. Onslow Ford's studio.

NEW COMPANIES REGISTERED.

National Motor Carriage Syndicate, Limited (52,692).—Registered May 25th with capital of £30,000, in £1 shares, to adopt an agreement with H. F. Joel, to acquire, develop, and turn to account any inventions relating to business of motor and cycle manufacturers, electricians, engineers, machinists, fitters, saddlers, rubber manufacturers, &c. The subscribers (with one share each) are:—W. F. Smith, 65, Warren Road, Leyton, electrical engineer; W. McAthy, 21, Kingswood Road, Wimbledon, accountant; G. W. Puttnam, 56, Mildmay Street, N., engineer; V. Baldwin, 29, Netley Road, Walthamstow, clerk; A. G. Gilbert, 10, Bryan Street, Islington, clerk; C. J. Mills, Brockley Rise, Honor Oak Park, S.E.; H. W. Peverett, 15, Bruce Road, South Norwood, clerk. The number of directors is not to be less than two nor more than six; the subscribers are to appoint the first; qualification, £100; remuneration as fixed by the company. Registered by Hyland & Atkins, 81, Cannon Street, E.C.

Gilbert Arc Lamp Company, Limited (52,679).—Registered May 25th with capital of £2,000 in £1 shares, to acquire and carry on the business of arc lamp manufacturer and electrical engineer, carried on at 35, High Street, Kensington, and to adopt an agreement with C. Gilbert. The subscribers (with one share each) are:—J. S. Hecht, 3, Gainsborough Gardens, Hampstead, electrical engineer; C. E. G. Gilbert, 35, High Street, Kensington, electrical engineer; L. Gilbert, St. Thomas's Hospital, S.E., physician; U. B. Gilbert, 3, Culverden Gardens, Tunbridge Wells, electrical engineer; A. E. Hosier, 15, Ashenden Road, Lower Clapton, clerk; R. Evans, 419, Strand, W.C., clerk; W. H. Martin, 15, King Street, Cheapside, E.C., solicitor. Registered, without articles of association, by W. H. Martin & Co., 15, King Street, Cheapside, E.C.

Peerless Accumulator Syndicate Limited (52,748).—Registered May 28th with capital £15,000, in £10 shares, to adopt an undescribed agreement, and to carry on the business of motor, cycle, motor car and carriage manufacturers and dealers, electricians, engineers, machinists, fitters, founders, wire drawers, tube makers, &c. The subscribers (with one share each) are:—A. J. Marsh, 61 and 63, High Street, Tooting, stationer; A. F. Talbot, 33, Defoe Road, Tooting, silk mercer; F. H. Edwards, 33, Belgrave Road, St. John's Wood, N.W., electrical engineer; W. A. Smith, 73, Sydner Road, Stoke Newington, engineer; A. E. Beck, 22, Kepler Road, Clapham, S.W., engineer; Mrs. A. Beck, 22, Kepler Road, Clapham, S.W.; W. F. Monk, 18, Kepler Road, Clapham, S.W., salesman. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first. Remuneration £100 each per annum, and 10 per cent. of the net profits divided. A. Carter is managing director, with £500 per annum. Registered by Jordan and Sons, Limited, 120, Chancery Lane, W.C.

CITY NOTES.

London Electric Supply Corporation, Limited.

A MEETING of this company was held at Cannon Street station on Tuesday last, but our representative was informed that the meeting was strictly private. An account, however, of the proceedings appeared in Wednesday's *Times*, from which we extract the following:—

Lord WANTAGE, who presided, reminded the shareholders that it was three years since a meeting of the members of the company had been held. The company fell into the hands of a receiver only when its affairs were in a somewhat lamentable condition, but that state of affairs had now passed away. Immediately after the receiver's appointment he made up the accounts of the corporation for the first half of 1894, which showed a loss on the working for that period of £3,484. There was also found to be due to other creditors £15,370, in addition to the debt of £80,000 to the debenture-holder. The company was early in the field and did a large amount of pioneer work, and undoubtedly made mistakes, as was often the case in such circumstances. He wished to avail himself of that occasion to say that he fully appreciated the forbearance and good feeling displayed by the shareholders when the misfortunes of the company and the consequent disastrous effects upon themselves were disclosed to them at their seventh ordinary general meeting in May, 1894. There had since been a considerable amelioration in the character and prospects of the Corporation. On July 16th, 1894, the lights furnished by the company amounted to 67,691, and increased at the end of that year by 4,339. In April last the total number of lights was 113,584 (a gain of 7,110 in four months), giving a total increase of 45,893 since the debenture-holder entered into possession. In the same period of 2½ years there had been an expenditure on capital account, under which further substantial property had been acquired. Debts which amounted to £15,370 had been reduced to £4,054. The whole of the interest on the debentures had been paid to the end of the last half-year, and £11,184 had been paid in reduction of the loans. The plant and machinery of every description and the whole system of mains had been kept up to a high state of efficiency, the whole cost of repairs and maintenance having been charged to revenue account. The expenses of management, including rent, rates, and taxes (which

amounted to £13,500 for the year 1893), had been reduced, and for 1896 these charges amounted to only £8,000. In the beginning of 1895 an understanding was come to with the Westminster and the St. James's Electric Lighting Companies by means of which antagonistic action in the way of cutting down rates was put a stop to, and a feeling of mutual confidence had arisen between the competing companies. An agreement had been concluded with the Chelsea Company to supply current on wholesale terms as soon as that company had provided the necessary machinery. They thought that furnishing wholesale supply of current was likely to prove a most remunerative part of their business in the future. They had been very glad to come to the aid of the Metropolitan Company during the winter of 1895, when one of the latter company's stations was burnt down. After speaking hopefully of the prospects for the present year, he said he had had to come to an important decision as to the advisability—or rather the necessity—of re-laying the so-called Ferranti trunk mains, which carried the current from Deptford to London. There were altogether four of these mains. On two occasions last March three of them broke down within a short time of each other, and had the last main also failed, no light whatever could have been supplied until the repairs had been made. As possible breakdowns of this nature were too serious a risk to be incurred, he at once determined to lay down two new trunk mains between Deptford and London to replace two of the Ferranti mains. A further outlay of capital would be required during the year to meet the anticipated further increase of business At the request of a meeting of some of the largest shareholders, he had consented to continue to carry on the undertaking as at present for another year. It was stated that at the present rate of the company's earnings, three-fourths of the preference dividend were covered, but this dividend would not become payable until the company had been reorganised.

West African Telegraph Company, Limited.

The ordinary general meeting of this company was held at Winchester House yesterday.

The Marquis of Tweeddale who presided said the decrease in the revenue amounted to £3,244, but of this £2,335 was due to loss in exchange, which amounted to £8,903 against £6,568 for the previous year. The receipts for messages, subsidies, &c., realised £1,935 less than in 1895, the expenses amounted to £17,898, or an increase of £424. There was practically no difference between the ordinary expenses of this year and last; the most important increase was under the head of cable repairs and renewals, and this amounted to no less a sum than £20,695, as against £6,298 for the previous year. The repairs this year had been found to be very much less, and that led them to expect a satisfactory report next year. The directors were unable to pay an interim dividend, and it was proposed to carry £9,000 to the general reserve, leaving a small balance to be carried forward. It was not a very satisfactory state of things, but the expenditure had been absolutely necessary in consequence of injury to the cables. They had successfully adopted the duplex system, and they would be in a better position to cope with extra work. They had made arrangements to give the French Government certain benefits on the West Coast route, but this had yet to be ratified by the Chamber; in the meantime the Government withheld their subsidies until the matter was settled. Speaking of the present half-year, the chairman said the traffics were fair, and as far as they had gone, there was a very marked reduction in the amount expended on cables. The retiring director and auditors were then re-elected, and the meeting terminated.

Amazon Cable Company, Limited.

The issue is announced by the Amazon Telegraph Company, Limited, of £125,000 5 per cent. debentures to bearer at the price of 95.

The original capital of £250,000 has been expended, and the calculations set forth in the original prospectus may now be considered as not having been realised.

We are now told that the debentures will be a charge on the subsidy of £17,125, and a floating charge on the whole of the assets and undertaking of the company. It seems, therefore, that half of the original capital has been considered to be practically lost.

We find now the position to be as follows:—

The interest and amortisation of the debentures is to be provided out of the £17,125 subsidy, leaving £5,875, or say £6,000, available with the traffic for working expenses, maintenance, and interest on the original capital, &c.

The subsidy has about 19 years to run, and therefore six years' interest and amortisation will have to be provided out of profits.

The traffic is again estimated at £36,250, although the actual results have worked out at about £21,000.

The working expenses are again estimated at £20,000; but we find the provision of £5,694 for the amortisation fund to redeem the original capital in 30 years has been omitted, while the cable after that period becomes the property of the Brazilian Government.

It is stated that the Brazilian Government have power, after 10 years, to purchase; but the financial correspondent of the *Daily Chronicle*, of June 1st, says he is not very fond of securities dependent upon the security of that Government.

Our previous contentions now apply to the new issue; everything depends upon the success or non-success of the plans about to be carried out for the restitution of the cable over the disturbed 400 miles.

The new contract with Messrs. Siemens is to cost £75,000, and there has been therefore the large sum of £50,000 raised besides, but for what purpose it has not been stated.

The prospectus does not say when the list closes.

Westminster Electric Supply Corporation, Limited.

An extraordinary general meeting of the shareholders of the above corporation was held at Eccleston Place, Belgravia, S.W., on Wednesday, 2nd inst., when the following resolution was submitted and carried:—

"That the resolution respecting the issue of the balance of 12,000 unissued ordinary shares, passed at an extraordinary general meeting held on November 28th, 1894, and confirmed at an extraordinary general meeting held on December 13th, 1894, be hereby rescinded, and that the following resolution be passed:—That in order to carry out the scheme for the cancellation of the founders' shares, which scheme has now been accepted by the holders of those shares, the directors be authorised to allot the 12,000 unissued ordinary shares of £5 each in the proportion of 120 shares for each founders' share, to be paid for at par, the founders' shareholders agreeing on their part to the cancellation of the founders' shares and all necessary legal steps to complete the transaction."

Lord Suffield presided.

The resolution was moved by Mr. W. Hayes Fisher, M.P., and Mr. E. Boulnois seconded. An amendment was moved by

Mr. Harold E. Young to the effect that the proposed resolution should be rejected in favour of the one originally passed in order to redeem the founders' shares. Since their last meeting the 8,000 shares which they then agreed to allot in exchange for the founders' shares had increased in value by £24,000. He maintained that the ordinary shares were of far more value than the founders' shares, which he advised them not to redeem unless on the original terms that were offered. He contended that the present proposal was altogether different from that which they were asked to sanction at their last meeting. The amendment was not seconded.

Mr. R. W. Wallace, Q.C., said that Mr. Browne Martin and himself were two of the largest holders of the founders' shares, and they would be perfectly contented to take the original offer which was made to them. In fact, most of the holders of founders' shares preferred the former offer to that which was now submitted, but it was suggested that there would be some difficulty in legally carrying out the earlier proposal. The founders as a body would much prefer what Mr. Young had suggested—to keep their founders' shares and one quarter of the surplus after paying the ordinary shareholders 7 per cent. and three-fourths of the surplus. The founders would obtain a good deal less from what was now proposed than they would if they remained in their present position, and they were only consenting to what was proposed for the sake of the company's prosperity.

The Chairman put the resolution, which was carried with one dissentient.

The Secretary (Mr. Frank Iago) afterwards read the agreement which is to be carried out between the company and the holders of the founders' shares; and on the motion of Mr. Boulnois, seconded by Sir Douglas Galton, a resolution was carried, with one dissentient, to the effect that the common seal of the company should be fixed to the agreement.

Blackpool and Fleetwood Tramroad Company.—A prospectus was issued at the end of last week offering £120,000 in £10 shares in the above company for public subscription. The company has been formed for the purpose of constructing and working an electric tramway on the overhead trolley system from Talbot Road Station, Blackpool, to Fleetwood. Part of the way, in all eight miles, the line will be a light railway skirting the coast for a considerable distance. The construction and other expenses are estimated at about £156,500. The list closed on Wednesday.

Stock Exchange Notices.—The Stock Exchange Committee have (1) appointed a special settling day as under:—June 10th, Willans & Robinson, Limited—Further issue of 4,500 ordinary shares, Nos. 22,501 to 27,000, and 4,500 6 per cent. cumulative preference shares, Nos. 52,501 to 57,000. And (2) ordered the undermentioned securities to be quoted in the Official List:—River Plate Electric Light and Traction Company, Limited—£125,000 5 per cent. first debenture stock; Western and Brazilian Telegraph Company, Limited—£382,230 4 per cent. debenture stock, in lieu of £148,500 6 per cent. "A" debentures and £180,000 6 per cent. "B" debentures.

Applications have been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to, Brunner, Mond & Co., Limited—20,000 7 per cent. cumulative preference shares, Nos. 60,233 to 80,232; Calcutta Electric Supply Corporation, Limited—20,000 shares.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending May 30th, 1897, were £929; week ending May 31st, 1896, £842; increase, £87; total receipts for half-year, 1897, £22,390; corresponding period, 1896, £20,535; increase, £1,855.

The Cuba Submarine Telegraph Company. The traffic receipts for the month of February were £3,782, as compared with £5,931 in the corresponding month of last year.

The Liverpool Overhead Railway Company. The receipts for the week ending May 30th, 1897, amounted to £1,310; corresponding week last year £1,809; decrease, £499.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 28th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £1,954.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, May 26th.	Closing Quotation, June 2nd.	Business done during week ended June 2nd, 1897. Highest.	Lowest
149,900£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	4 — 5	4 — 5	...	...
923,960	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	49 — 52	52 — 55	54	52½
3,038,020	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	94 — 95	97 — 98	98	94⅜
3,038,920	Do. do. Defd.	Stock	...	...	...	7⅜— 8¼	9 — 9½	9⅜	8 13/16
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15 — 15½	15 — 15¼	15⅜	15⅛
75,000£	Do. do. 5 %, Debs., 2nd series, 1926	100	5 %	5 %	...	113 —117	114 —118	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3½— 3⅝	3½— 3⅝	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	173 —177	173 —177	...	...
400,000£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	101 —102	102½—103½	103⅜	101¼
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	1/16— 1/16	1/16— 1/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	9½— 10½	9 — 10	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9½— 10½	9½— 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	105 —108 %	105 —108%	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	8⅜— 9½	8⅜— 9½	9 1/16	9
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	16¾— 17¼	16¾— 17½	17 5/16	17
70,000	Do. 6 % Cum. Pref.	10	6 %	6	...	18 — 19	18 — 19	18¼	18⅜
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	103 —106	103 —106	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	127 —130	127 —130	128½	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7½	17⅞— 18¼	17⅞— 18¼	18¼	18 3/16
35,500	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	101 —105	101 —105	...	...
133,100	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	102 —105	102 —105	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	128 —131	128 —131	...	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	101 —105	101 —105	101	...
69,200£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	102 —105	102 —105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	105 —108	105 —108	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	107 —110 %	107 —110%	...	...
150,227	Globe Telegraph and Trust, Ltd.	10	4⅛%	4⅛%	...	11¼— 11⅜	11¼— 11⅜	11 1/16	11⅛
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17 — 17½	17 — 17½	17 5/16	17
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	10%	24½— 25½	25 — 26	25½	...
160,000	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	102 —105	103 —106	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	54 — 57	54 — 57	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	6⅝— 6¾	6⅝— 6¾	7 1/16	6⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	...	...
1,329,471	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —109	105 —109	107½	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	⅝— ¾	⅝— ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 — 110	107 — 110	...	...
11,839	Reuter's Ltd.	8	*nil*	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	135 —140	135 —140	...	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3½— 4	3½ — 4	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	4 %	nil	5 — 6	5 — 6	...	...
213,400	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	101 —104	101 —104	104	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	...	... ...	... — ...	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	... ...	... — ...	...	...
64,256	Western and Brazilian Teleg., Ltd.	10	3 %	3 %	2 %	7⅜— 8¼	7⅜ — 8¼	8⅛	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½— 7	6½— 7	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	1⅜— 2¼	1⅜— 2¼	2⅛	1⅞
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	1 %	⅝— 1⅛	⅝— 1⅛xd	1	..
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 11½	10½— 11 xd	10½	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½— 10½	9 — 10 xd	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	104 —108	104 —108	...	...
162,200£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	13 — 14	13½— 14½	14	13 1/16
20,0 0	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6½— 6⅝	6½ — 6⅝	...	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	10¼ — 10⅜	9⅜—10½	10 1/16	10⅛
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	112 —115	112 —115	...	..
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	23½ — 24½	23½— 24½	23 15/16	23⅜
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 — 18	17 — 18	17⅛	17⅝
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —136	131 —136	133½	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	*nil*	*nil*	12½— 13	12⅜— 13½	13½	12⅝
10,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	6 %	6 %	15 — 15½	15 — 15½	...	...
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	14⅜— 15¼	14⅜-- 15¼	15	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	9¼— 9⅜	8⅜— 9½	9	8⅜
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	17 — 18	16½— 17½	17 1/16	17
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	13½— 14½	13½— 14½	...	...
220,000	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	120 —124	120 —124	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	15 — 16	15 — 16	16	15½
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	15½— 16½	15½— 16½	16⅜	..
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10⅝	10⅛
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
67,900	*Westminster Electric Supply Corp., Ord.. 101 to 60,000 ...	5	5 %	7 %	9 %	15½— 16½	15 — 16	15⅞	15½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.
‖ Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation May 26th.	Closing Quotation, June 2nd.	Business done during week ended June 2nd, 1897. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	2½%	...	...	1½ — 1½	1½ — 1⅝	1⅝	1½
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1⅝ — 1¾	1½ — 1⅝	1 9/16	...
125,000£	Do. do. 4½ % Perp. Deb. Stock... ...	Stock	4½%	...	...	104 —108	104 —108	105¼	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	95 — 99	95 — 99	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9¾ — 10¼	9¾ — 10¼	10 1/16	...
143,103	Do. do. do. £6 paid	10	...	...	...	5⅝ — 6¼	5⅝ — 6¼	5⅞	5⅛
51,951	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1¼ — 1⅜	1¼ — 1⅜	1⅜	1 1/16
54,521	Do. do. Def. do. £5 pd. ...‖	...	...	...	...	4¼ — 4⅜	4¼ — 4⅜	...	...
630,000£	City and South London Railway	Stock	1⅛%	1 1/16%	1 1/16%	58 — 60	58 — 60	59½	59¼
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1⅜ — 2¼	1⅜ — 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	1⅜ — 2¼	2 — 2½	2 7/16	2
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3 — 4	3½ — 4½	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	4½%	4½%	...	105 —110	105 —110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	...	1⅝ — 1⅞	1⅝ — 1⅞	1⅞	1⅝
16,343	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2⅜ — 3¼	2⅜ — 3¼	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	⅝ — 1	¾ — 1	15/16	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	½ — ⅝	½ — ⅝	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	11 — 13	11 — 13	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18 — 19	18 — 19	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	108 —113	108 —113	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	21½	21
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	104 —107	104 —107	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2 7/16%	2½%	12 1/16 — 12 5/16	12 1/16 — 12 3/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15⅝ — 16¼	15½ — 16	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	34 — 37	35 — 38	36½	35½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	103 —106	103 —106	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅝ — 11¼	10⅝ — 11¼	11¼	10 15/16

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7½%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9⅛.
British Electric Traction, 12⅜—13¼.
Electric Construction Corporation, 6 % Debentures, 103—106.
House-to-House Company, 7 % Preference, of £5, 10—10½.
Do. do. 4½% Debentures of £100, 109—111.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 12¼—12⅜; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8¼. Dividend, 1896, on Ordinary Shares 7 %.
London Electric Supply Corporation, £5 Ordinary, 1⅞—2⅛.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8⅜—8⅝. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount, 2 per cent. (May 13th, 1897).

REVIEW.

Heat and Heat Engines. By W. C. POPPLEWELL. 1897. The Technical Publishing Company, Manchester.

This book is a reprint of a series of articles which appeared in our contemporary, the *Practical Engineer*, and it is on the whole a very excellent publication if we allow that another treatise on heat engines is really required. Our author, however, writes for engineers, and we look in vain for the useless poundal, of which of late we have been hearing so much, and find instead the simpler and more reasonable units to which engineers are accustomed, and with which they have so far got along very well.

He is very plain and understandable in what he writes, and deals in succession with a few elementary principles, with heat measurement, the nature of heat, specific heat, and the mechanical equivalent. From these he passes on to heat in its relation to gases, and considers the expansion of gases and work done in expansion and compression.

One section of the book is given over to gas and oil engines, which take precedence of the time-honoured steam engine. On the efficiency ratio of heat engines, it is remarked, and, we think with sense, that to consider efficiency on the basis of a reduction to absolute zero of the working fluid is stretching a point. The point is illustrated by a hydraulic parallel in shape of a turbine discharging water at an elevation of 500 feet above sea level when utilising a fall from 1,000 feet above sea level. It is asked, is the efficiency of such a turbine to be practically stated as half what it really is, because of the unused 500 feet, which it is impracticable to use. Yet the absolute zero is as difficult to attain and is scarcely suitable as a datum line of efficiency. Students of air motors may profitably study Chapter XIII. on "Compressed Air." They will more readily understand the need for stage compression and for some heat application during expansion. In the section on internal combustion engines will be found useful figures in the shape of the properties of various gases which are met with in connection with this class of motor. To understand this section the student ought to have some knowledge of the chemistry of combustion, and generally of elementary chemistry and chemical physics. In speaking of deferred combustion so called, in gas engines, we note that doubt is thrown upon the theory of dissociation so much advanced by a former editor of our contemporary. It is hinted that the effects of the supposed dissociation may be due to increase of specific heat at high temperatures, and we ourselves are inclined to favour this idea.

Not much information is afforded on gas producers for the production of poor gas for power purposes, though this might well have been extended. At the same time the section on gas engines is distinctly good. In regard to the relative efficiency of gas and steam engines, while it is allowed that the gas engine has a higher thermal efficiency than a steam engine and boiler, it is considered only fair that the real basis of comparison should be the amount of coal used per unit of power. The special fault or rather shortcoming of the gas engine is that it cannot be so easily controlled as a steam engine, a statement true of all internal combustion engines which have not a reservoir of fluid under pressure. The weakest section in the book is that on the oil engine, to which less attention has been paid that the oil engine warrants. Considering the many places in the country where an isolated oil or naphtha engine could be used with entire freedom from danger to other property, it is a matter of surprise that naphtha motors of the kind used on the almost defunct motor car should not have come more into use. The last third of the book is given up to the time-honoured steam engine. There is something about the steam engine that endears it even to believers in the future of the internal combustion motor. No matter what its condition, if steam be turned into a steam engine it will

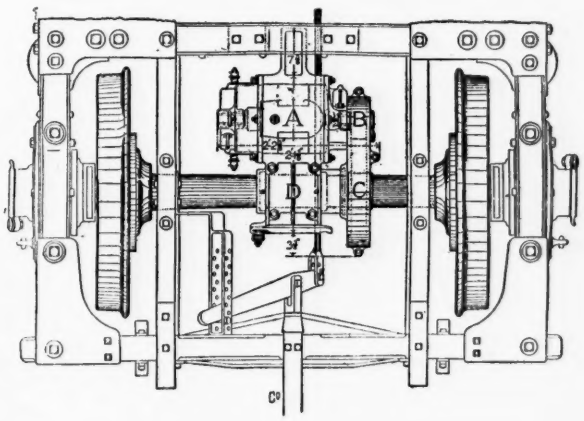
endeavour to move. The steam engine is a very sure and certain prime mover, and this fact will ever tell in its favour. We are glad to see that our author does not attempt to deduce any rules for calculating the practical efficiencies of steam engines because the conditions are so very varied. Indeed, one can only generalise upon the effects of internal surface area, roughness of internal surfaces, and other of the many factors involved in the question of internal condensation, &c. Altogether, the section on the steam engine is well written, and we consider that the book as a whole has much to recommend it.

TRAIN LIGHTING.

How very remarkable is the spirit which appears to animate those who have the control of such matters in the United States, and those who exercise a similar power in England in the application of not merely that which is novel, but especially that which it is felt is an improvement, and as such acceptable to the community at large! With us, with but one notable exception, the Brighton line, railway train lighting by electricity appears to have become practically a dead letter. Gas, with all its possibilities of danger, and its imperfect illumination, gains the day. It is so easy of manipulation! And yet we venture to assert there are few, either railway men themselves, or members of the general travelling public, who, if the choice were before them, would not unhesitatingly express themselves in favour of the electric light as an illuminant. Why, with these facts patent to them, our chief railway companies should abandon, as in practice they appear to have done, all efforts to bring to perfection that which has so far held out every probability of ultimate success, it is hard to say, except on the pretext that their vehicles are lighted more or less satisfactorily, and that so long as the public are satisfied there is no need for improvement. Such, of course, may be the view, but we are inclined to think it will not remain so long. Gas carries with it one powerful objection: its liability to danger, and of that it cannot be divested. It affords, so long as the arrangements are good, the burners sufficient and in perfect order, and the pressure satisfactory, a readable light; but with a decrease in the pressure, any derangement in the draught, and faulty burners, the light is disappointing. In economy, we believe we are correct in saying that on the Brighton line Mr. Houghton has been able to show that the cost of the electric light is less than that of gas.

In America, the subject is never allowed to rest. From time to time improvements—slight in themselves, but still an advance—are being chronicled, evidence that there, at all events, the railway magnates are alive to the advantages of the electric light, and that its use is not only a source of attraction, but of economy. All important cars there are lighted electrically, and it is, perhaps, not too much to say that no railway company would regard its express cars as up-to-date, or properly equipped, without the electric light. Our contemporary, the *Electrical World*, in one of its most recent issues, directs attention to an improved method which has recently been applied successfully to a car running between Jersey City and New Brunswick, over the Pennsylvania Railway. The car is lighted by some 28 16-C.P. lamps, the current for driving which is generated by a small dynamo placed on one of the car trucks, and geared to one of the axles. The car also carries a set of batteries, so that the lights can be fed from either the dynamo or the cells. The automatic gear for cutting the cells in and out, for arranging the brushes according to the direction of rotation, and for otherwise meeting the difficulties contingent upon speed, &c., are in practice, those which have been used by the Midland, Brighton, and other companies who have given attention to the subject; but in the arrangement of the generating gear there is a sufficient novelty to entitle it to the consideration of our readers. We reproduce from our contemporary the illustration showing the method of connecting the dynamo to the axle of the car. The dynamo is completely enclosed in an ironclad casing, and is suspended from the car axle, which is in no way altered or changed. By means of two clamp rings, one at each end, a split sleeve is fixed around the centre of the axle. On this sleeve the dynamo, A, is pivoted on one side, while the other side is supported by means of a spring. A tooth-wheel, C, is bolted to the split sleeve, and gears into a pinion, B, on the shaft of the dynamo. This gearing is entirely enclosed, runs in oil, and is said to work well.

The requirements of railway traffic are, of course, very different on the American Continent to what they are here. Their trains and vehicles run much longer journeys, and their cars become for the long journey passengers a veritable place of abode, in which he has to live night and day. The comfort and convenience of the traveller has to be studied, and those lines which devote the most attention to this secure



the greatest patronage. We do not think our own railway men are insensible to this. There is no doubt a spirit of competition, but it is questionable if it goes far enough. One company will fit out a luxuriously-fitted train, upholstered and decorated in the most expensive manner, to be followed by "ditto" on the part of another company, yet each and all furnished with gas. Although our trains do not traverse such an extent of country as those in the States, many of them experience journeys long enough to entitle their passengers to every consideration; and we commend to those companies whose trains do traverse these long journeys the propriety of following the example set by some of the chief lines in America. The equipment of these trains cannot be a serious matter to a large company, and as they usually run *en bloc*, the difficulties would be even less than where the train is required to be broken up at points on the journey.

THE INSTITUTION OF CIVIL ENGINEERS.

(*Continued from page* 737.)

"THE TRANSMISSION OF POWER."

By John Hopkinson, M.A., D.Sc., F.R.S.

The section of the subject of the transmission of power upon which I have been requested to address a few remarks is one with which I find it extremely difficult to deal. All other methods of transmitting power than by electricity and water is an extremely large subject, which it is really impossible to handle in 10 minutes. Further, it is a subject which is very old and trite, and upon which it is impossible to say anything at all of an original character. In fact, I may say that to Messrs. Preece and Ellington have been allotted in this matter the cream, and to me has been allotted the skim milk. That being so, even though the time during which I shall have to occupy you is so short, I shall venture to touch upon their subjects as well as mine; in fact, to improve the quality of my skim milk by stealing a little of their cream.

The methods of transmitting power which are well known to all of us other than by electricity and water-power appear to be those of ordinary gearing and shafting, of transmission by ropes, and of transmission by compressed air or by steam. Consider for a moment the broad characteristics of these five modes of transmission. The losses of energy in four of them are, in fact, very similar, and closely analogous to the ordinary well-known losses by friction. This is obviously the case in water-power transmission, in transmission by gearing, in transmission by ropes, and it is, I think, also the case in

transmission by electricity, for the loss by electrical resistance is closely analogous to the loss by frictional resistance; and in the transmission of power by electricity the main source of loss is really by resistance. On the other hand, the losses in the case of transmission by compressed air belong to a totally different class. When the air is compressed it is inevitably heated, and when it expands, doing work at the receiving end of the system, it is inevitably cooled. The heat of the compressed air cannot practically be retained, but it is lost by conduction through the containing chamber and through the pipes which convey it. Again, in expansion the heat of surrounding bodies cannot be kept out of the cool air, and hence results a loss of power which is not analogous to a frictional loss. The methods of diminishing these losses are totally distinct in kind from those which would be adopted in the other four methods of transmission. We must look for them in the direction of avoiding as far as possible the conduction of heat to and from the working material through surrounding bodies, or in some system of regeneration having the same end in view, viz., avoiding the equalisation of temperature by conduction. This peculiarity of transmission of power by compressed air, although it involves very serious losses when applied in unsuitable cases, possesses also particular advantages for particular purposes. I refer to such work as that of tunnelling in such situations as the St. Gothard, the Vorailberg, or the tunnel about to be made on the Simplon route. Here the air which is forced into the tunnel for the purpose of propelling the drills is afterwards used for ventilation, and the fact that it is cooled in doing its work is an additional advantage in cooling the end of the tunnel. These are advantages which are absent from the other four methods of transmitting power, and render it, I think, certain that for this particular purpose, compressed air is the method which will be universally employed in the future.

Comparing, now, the other methods of transmission, one is at once struck by the great flexibility of transmission of power by electricity. The electrical conductors can, of course, be taken through all sorts of positions without trouble or inconvenience, and are very easy to repair. Further, transmission electrically can be effected at very much greater distances than can be conveniently done by any other method. It would seem that electricity must be the agent when transmission is to be made to long distances, as from where there exists a great water-power to the points at which that power can be used, and in very many cases where it is advantageous on account of its convenience. One sees electricity coming into competition with transmission by ropes or cables, both for tramways and in its use for cranes. For tramways there is no doubt that electricity has practically taken possession of the field on account of its cheapness in all cases except those where the traffic is extremely heavy, or where the gradients are extremely severe, so that there are points at which there would be insufficient adhesion between the wheels and the rails. With regard to cranes, of course all of us are familiar with the type of rope-driving which was in use 20 years ago, in which a high-speed rope was used for driving cranes by means of friction-wheels. The far greater convenience of electric-transmission will, I think, entirely supersede the rope crane.

Comparing electrical transmission with the use of shafting and gearing, we already see that in many factories power is transmitted electrically, and a large amount of gearing is rendered unnecessary. It has there the advantage that buildings may be constructed and machinery arranged without regard to gearing and shafting. For many purposes, however, electrical transmission has a formidable competitor in transmission by water pressure; each has its own field. It is inevitable that with electrical transmission of power high speeds of rotation must be used, and for many purposes this is inconvenient; for example, for lifts and cranes working at a slow speed. But notwithstanding the fact that there seems undoubtedly to be many places where hydraulic transmission will permanently be better suited to the purpose than electrical transmission, there can be no doubt that there are many cases in which at the present day hydraulic transmission is used which will ultimately be effected by electrical transmission of power. Consider, for example, the case of transmission upon our ships of war. Here we have at the present time, as a rule, transmission of power either by means of water pressure or by means of steam pressure. The consequences of the destruction of a steam-pipe by a projectile would be extremely serious, and in any case the destruction either of a steam-pipe or of a water-pipe would involve a very considerable amount of trouble in repair, whereas the breaking of the continuity of an electrical conductor would be easily and quickly made good. In conclusion, I would remark that in transmission of power, electricity acts really as a mechanical gearing. As I pointed out at the outset, the losses are essentially of the same kind as frictional losses, and quite distinct from the losses in transmission either by compressed air or by steam, which depend essentially upon thermo-dynamic laws.

The discussion on the "Transmission of Power" was taken on the three papers, two of which have already appeared in the ELECTRICAL REVIEW. In inviting remarks on the papers Sir FREDERICK BRAMWELL, the chairman, referred to the omission to mention two modes of transmission of power, one of which was obsolete but the other was used in every day practice. The obsolete method was that of exhaustion, which was applied to a considerable extent at the time of the opening of the St. Catherine's Dock. The second method which was in constant use was the transmission of power by gas, and that was the cheapest of all and very readily applied.

Mr. SPRAGUE, in showing the superiority of the electric motor over other types of motors, said it was distinguished from all others in an ability to return power to the line under certain conditions. The point, however, which the speaker endeavoured to make clear was, that the energy demanded in an electric motor depended on the amount of work it was required to do.

Prof. FORBES was the next speaker, and in giving various interesting facts on the transmission of power by electrical means, said that at Niagara there was no desire to transmit power great distances; the conditions there were very different to what they were in other countries. In the case of Niagara they were competing with cheap steam power, coal costing only a dollar and a quarter per ton, and the cost of steam power was about the same 100 miles away. Therefore, as the profits on an electric transmission system diminished the greater the distance traversed, it was commercially sound to supply power only in the immediate neighbourhood of the Falls, if the demand were sufficient. After referring to the principal objects of the Niagara system, to supply current of every kind to the consumer, the speaker referred to the distance to which electricity could be transmitted to compete with other systems. The distance depended upon the electrical pressure and the cost of developing the power; in some cases, the question of transport of materials and cost of labour arose, but generally the most variable factor was the price that would be paid for the power where it will be delivered. The limit of distance might be with cheap coal 100 miles, but there would be cases where it would pay to transmit energy 1,000 miles. The speaker mentioned that some time ago he received a letter from South Africa, asking if it were not possible to economically transmit power from the Zambesi Falls to the mines in Mashonaland, on going into the question and after visiting South Africa he found the idea was sound. The cost of power at the mines was heavy and the demand was a continuous one. Referring to the utilisation of the Falls of the Nile, he trusted that when these works were done English manufacturers would come forward with suitable machinery. Referring again to the Niagara scheme, the Professor said that many people maintained that the transformers would cost about £3 per horse-power, but they eventually got them at 10s. per horse-power, and whereas it was said they would not get anything like 96 per cent. efficiency with low frequency they obtained 98½. Under some circumstances, if the capital value of the plant was £10 per horse-power, and the copper in position cost £80 per ton, then by the methods that had been developed for the Victoria Falls, if the greatest virtual potential difference between any part of the electric conductors and the earth be 7,500 volts, the capitalised cost at different distances would be as follows:—

Transmission to	100	miles,	£20	per	horse-power.
" "	200	"	£44	"	"
" "	300	"	£80	"	"
" "	400	"	£130	"	"

Mr. FREDERICK WALKER rather objected to the remark of Mr. Sprague that the hydraulic method made no return into the system. He instanced Barry Dock, where the lowering of the trucks from a higher to a lower level pumped water into the accumulators. It was a mistaken idea to suppose they could not transmit considerable distances by the hydraulic system; it was quite a common thing to have 5 or 6 or even 10 miles of pipes running round Docks. Referring to the losses in line shafting, he did not think they were ever more than 20 per cent. What they wanted was some actual figures showing the cost of running machines by electricity, as well as by hydraulic methods.

Mr. T. PARKER, in combating the conclusions of a previous speaker on the cost of electric traction in Birmingham, pointed out that accumulators were employed.

Mr. ALEXANDER SIEMENS said that the commercial elements were the only ones to consider in a transmission scheme; they did not undertake transmission of power for scientific purposes. As an instance of how small the repairs and maintenance may be in motors, the speaker instanced a motor which had been working a pump since 1874 at the late Sir William Siemens's place at Tunbridge Wells, and it had only required a short time ago an alteration to the brushes.

Dr. EDWARD HOPKINSON, looking at the question more from a distribution point of view, said although they could show satisfactory commercial results as far as dynamos and motors were concerned, there was great difficulty in getting down the cost of the gear required between the motor and the machine. He had found in bleach works that the cost of the intermediate gearing and the cost of the switching arrangements often amounted to 50 per cent. of the cost of the plant. It was also of very practical importance at the present time to obtain the best means of giving variation of speed with approximately equal efficiency throughout the range.

Mr. MARK ROBINSON, of Messrs. Willans & Robinson, spoke of the success attending the use of electrical motors at their works at Thames Ditton. They had been fixed in dusty places, and had given so little trouble, that they were adopting an extensive system of electrical driving at their Rugby works.

Sir FREDERICK BRAMWELL said, assuming gas at 2s. 9d., it would be possible to get a brake horse for a little over ¾d. per hour; assuming a Board of Trade unit at 4d., a brake horse-power would cost $3\frac{7}{10}$ths pence. Assuming high pressure water at 750 lbs. pressure at the price of 3s. per 1,000, it would be possible to get a brake horse-power for 4½d.

The AUTHORS of the papers briefly replied to the points raised, and the discussion, which had not elicited very many important points, and which indeed was generally of a disappointing nature, closed.

"SHOULD GENERATING PLANT BE MOUNTED ON SPRINGS?"*

By JAMES SWINBURNE, M.Inst.C.E.

This is really part of a larger question: Should moving machinery be mounted on springs? The question concerns both the health of the moving machinery, and of the people who may be moved by it. In central stations and in passenger steamers, the shaking caused by

* Read before Section VII., May 26th.

machinery is most serious: in flour mills, for example, it is rather a question concerning the gear itself.

If we consider, say, a direct acting-pump in space, it is a system that of course cannot move its centre of gravity as a whole. If then its pistons and plunger move in one direction, the rest must move in another direction, the distance depending on their masses. Any imperfectly balanced machinery must therefore move its bedplate if freely suspended. A perfectly balanced engine is thus an engine whose centre of gravity never varies relatively to its bedplate. This definition is really too small, because a moving system, such for instance as two cranks at 120° on opposite ends of a shaft do not change their centre of gravity, but give the bedplate a rocking but non-translational movement. A gas engine with a fly-wheel, similarly, tends to rotate its bedplate at each impulse, round an axis parallel to that of the shaft. A balanced engine is therefore really one which does not move its bedplate if freely suspended. Such an engine is practically never realised.

When an engineer sees an engine bedplate moving, his first instinct is to bolt it down; it then moves a little less, but still moves, and he has a sort of feeling it must shake itself to pieces if allowed to move. Bolting down an engine to a bed of concrete is merely increasing the size of its effective bedplate, but the whole bedplate, including the concrete, must now be moved. It rests on the earth, moves slightly, and communicates vibration to neighbours who are longing to be compensated for disturbance.

Sometimes the concrete bedplate is isolated by mounting it on felt; that means that the larger bedplate is mounted on rather imperfect springs.

A rather striking case is that of church bells. Bells are very much out of balance, and the bedplates are mere cages of timber; so the bedplates would tend to move a good deal. The bell people do not like to see it move, so they wedge it to the steeple, and the result is a cracked steeple. The consequence is, that you often hear that such a church has a very fine peal of bells, but they cannot be used, as the steeple will not stand it. Though this may be a relief to people whose ears are in tune, it might be cheaper not to make bells, than to make them and hang them so that they cannot be used.

The question is, if the bedplate of an engine wants to move, why should it not have free play? As far as the engine goes, a little thought will show that all its parts are subjected to smaller stresses if the bedplate is free to move. An engine will therefore wear longer if it is allowed to move its bedplate. As to the foundations, if the bedplate is allowed to move, no foundations to speak of are needed; and there is no vibration communicated to the ground.

The writer has tried this arrangement on a small scale. There is a small dynamotor on one of the top floors of Mr. Crookes's house which is very much out of balance, and rendered the house uninhabitable at first. It is now on springs and makes no noise. There is also a dynamotor for electrolytic work in the writer's laboratory. It is on springs, and no one has any inkling of a chance of complaining.

In passenger steamers the throb of the engine is exceeding unpleasant; in fact, many people would rather go by a slower boat than travel 21 knots, and be at the same time shaken 42 more knots by his pedometer. Mounting marine engines on springs seems rather a bold suggestion, and perhaps we ought not to begin there. The moving systems are so heavy in proportion to the fixed (or "attached" is the better word), that the marine engine is a particularly difficult case.

The idea of mounting engines and dynamos on springs was mooted by the writer, in *Industries* in 1892. The editor, in addition to being a sound engineer, is a man of caution, so the communication came out as an anonymous letter. Mr. W. W. Beaumont has, however, done a great deal of real work on the subject, especially in connection with flour mills. He has introduced his "vibromotor" principle. This principle is simple. "If gear wants to wobble, let it wobble." The idea seems sound; the discussion will, perhaps, throw new lights on it.

DISCUSSION.

Mr. ALEX. SIEMENS said that his firm many years ago overcame vibration in the case of a gas engine by using a thick layer of India-rubber and felt. Prof. Ewing quoted examples to show the advantage of a non-rigid connection, and the Hon. C. A. Parsons showed how that they had got rid of vibration at the Hotel Cecil by using three or four layers of India-rubber about an inch thick, with iron plates between. Sir Henry Mance considered that the vibrations supposed to be set up by central stations were very much exaggerated. Mr. Dolby had found that the use of door mats between the bed-plate and the foundations of gas engines checked the vibration. Mr. Spagnoletti spoke of the peculiar course taken by vibration waves, and some interesting experiences were given by Mr. J. Wolfe Barry as to vibration caused by fans. The vibrations were supposed to have been caused by engines working the fans, but it was found that the vibrations were caused by the air propagated by the fans. Mr. Preece contributed some remarks on vibrations set up by air, and in recounting some of the troubles they had met at the Post Office, said one had arisen from the pulsations of steam in an exhaust pipe, but they had been unable to trace the cause of vibration in one room, which was entirely out of connection with anything that might cause vibration. It had been suggested by Capt. Sankey that there might be sympathy between the rate of vibration of the floor and one of the engines, and they were fixing a scaffold pole under the floor to endeavour to overcome the trouble. Mr. Wolfe Barry, speaking of some experiments that he had made years ago, found that dry peat propagated very little vibration. Mr. Crompton spoke of the varying conditions of vibration. At Vienna they had trouble years ago, especially when the engines were synchronised. They tried springy asphalte, and the condition of things set up by this was far worse; they took it out and put in solid foundations, and the vibrations were much lessened. In another instance when springy foundations were used the swing on the steam pipes was so great that vibrations were communicated to the surrounding buildings. In the Agricultural Hall the foundations were made to rock, but the vibrations were so great and caused such destruction of the connections that they were obliged to alter the foundations. Mr. Worby Beaumont remarked that though springs deserved most careful consideration, they wanted something more than springs; they wanted something for the disturbing force to act upon. Mr. Swinburne closed the discussion by making a few brief remarks.

"THE EQUILIBRIUM SYSTEM OF FEEDING ELECTRIC RAILWAYS."*

By C. E. P. D. SPAGNOLETTI, M.Inst.C.E.

There can be no doubt that the subject of electric traction is one that has a great future before it, and is commanding the serious attention of many leading engineers. Its very rapid progress and development in America is now in this country and on the Continent producing the idea that it is likely to become the prominent motive power. The author, therefore, ventures to bring before the conference for discussion and criticism a system for working long lines of railways by electricity.

The author will not refer to existing systems, but will simply describe the method he desires to bring under notice.

The great desideratum in working an electric railway is that the potential on the line should be practically equal at any and all points of the conductor, and the best way, in the author's opinion, of obtaining this desired end is by working on a system of equilibrium, which he proposes to do in the following manner. For example, take a line of railway, say of 100 miles in length; at each end of this line establish a generating station connecting the positive poles of direct-current shunt-wound dynamos to each end of the conductor, the dynamos being equal in their output. If the current so sent is insufficient for the requirements of the line and number of trains thereon, place at intermediate convenient points additional generating stations connecting the positive poles of similar dynamos at each of these stations to the main conductor. The result will be that each station sending the same current *i.e.*, the positive into the conductor or feeders, equilibrium is established, and no current will flow until a train is on the line. Now, at whatever point or points a train or trains may be taking current from the conductor, the potential will be practically the same, because the loss by resistance of the conductor from the distant station or stations will be made up from the station or stations at the opposite end, and to which the train or trains are nearer.

The resistance of the conductor being equal throughout, the loss from dynamos must be the same at any given distance, and they will balance themselves.

In each generating station the author uses shunt-wound direct-current dynamos, with an automatic electric governor to regulate the throttle valve on the steam pipe, so that whenever the line is free from trains, which is not often likely to be the case, and equilibrium is established, and no current is flowing in the conductor, the throttle valve is closed, and the steam regulated accordingly.

The author does not wish for a moment to create an alarm in the minds of locomotive engineers, or a fear that if electric railways become general their occupation would be gone. They would only have to turn their attention to stationary engines instead of locomotives, as the latter would disappear as a requirement of a railway company. Electric motors would be attached to the axles of the various vehicles running on the line, and their own dead weight, with their live or dead weight cargoes, would afford the necessary friction on the rails. The unnecessary load of large engines, weighing some 80 tons or more, would not have to be carried throughout the journey.

With regard to the cost of such a system, there would be as a set-off the value of the locomotives, tenders, water-cranes, coaling- or coking-stages, at various parts of the line, with the necessary attendants. The sheds for stabling engines would no longer be required, and would save a large expenditure in buildings and maintenance. Large steam-worked turntables would not be wanted, the permanent way would suffer less wear and tear, bridges over which trains would run would be subjected to less strain, stations, by the absence of steam and smoke, would not need so frequently painting, and there are several other minor matters which tend towards economy. The author believes a very considerable saving would be the result of the introduction of electric working as against the expenses and repairs of a railway locomotive department, against which there would be the electric plant cables, stations, conductor, feed rail or overhead trolley system, motors, &c., and if average cost of engine and tender be taken at £2,300 each, and a railway has a thousand or more engines, there would be and enormous surplus in favour of the electric system, either in first cost or conversion of system.

Very great convenience would be afforded to those requiring special trains. A carriage could be provided at once, and the delay consequent on getting an engine and waiting until she is sufficiently in steam to take the journey (perhaps half an hour or more) would be saved, as by the electric system the journey, if about 20 miles, could be run while the engine is getting ready. The economy of such a system is marked, as there would be no waste in the consumption of power, whereas an engine required for one or two coaches would be quite capable of taking a dozen.

It would also be possible for railway companies using a system of this kind to have generating stations at all intermediate large towns *en route*, where they could from the same building work the trams of the town, making them tributaries to the line, as well as affording local convenience and economy.

* Read before Section VII., May 27th.

"THE APPLICATION OF THE STEAM TURBINE TO THE WORKING OF DYNAMOS AND ALTERNATORS."*

By the Hon. Charles Algernon Parsons, M.Inst.C.E.

The steam turbine has been developed into a motor, which utilises steam with a high degree of economy. It possesses considerably simplicity, and as its speed of revolution is high, and it runs with perfect steadiness, it is manifestly a suitable motor for the driving of dynamos and alternators.

The first compound steam turbine directly coupled to a dynamo was constructed in the year 1884. It ran at 18,000 revolutions per minute, and gave 6 electrical H.P.; successive improvements were introduced, and it was further adapted to condensing. Within the last five years, direct coupled turbine dynamos and alternators of 500 to 700 electrical H.P., both condensing and non-condensing, have been constructed and put to work, and at the present time above 30,000 H.P. of these motors are at work in England.

The Compound Steam Turbine.—The compound steam turbine of the "parallel flow type" consists of a series of parallel flow turbines set one after the other on the same shaft, so that each turbine takes steam from the preceding one, and delivers it to the next. The steam entering by an inlet all around the shaft, passes through the successive turbines of gradually increasing area of passage-way, and is expanded by small increments of volume at each turbine, till it arrives at the next series of turbines; these are of larger diameter, and consequently greater peripheral speed and capacity, and they allow of further gradual expansion. The steam then flows to the last series of turbines, where the expansion being completed, it passes to the exhaust-pipe. The rows of turbine blades are formed of hard brass, and accurately shaped; those keyed into the shaft project outwardly, and nearly touch the case; those keyed into the case project inwardly between the moving rows, and nearly touch the shaft. The turbines are so proportioned that the steam passes from one row to the next throughout the entire turbine with the most suitable velocity for economical working under the prescribed conditions. On the right are the dummy or rotating pistons to balance the end pressure of the steam.

In the compound steam turbine of the "radial flow type," the rows of turbine blades are keyed into and project from the faces of moving discs attached to the shaft, and fixed discs attached to the casing. The course of the steam is outwards, through the rings of blades, then inwards, and again outwards through the blades on the succeeding disc, and so on, and the expansion is completed in passing outwards through rows of turbine blades on both sides of the large disc. The end pressure is here, as in the case of the parallel flow type, balanced by a revolving piston. The bearings are of special but simple construction. Around the bush in which the shaft revolves, are placed three concentric loosely-fitting tubes, truly bored and centred; the action of these tubes being to form concentric extremely thin layers of oil around the shaft, which act as a cushion and prevent hammering or vibration of the shaft arising from any small errors of balance that may be present in the moving parts. The bearings are kept continuously supplied with oil by a pump, and in the case of large plants an oil-cooler is fitted, through which the pump forces the oil to the bearings. Generally the bearings are fed from open oil boxes, but sometimes they are closed, and the oil forced in under considerable pressure.

The Governor.—The governor chiefly used has been one in which the steam admission valve is worked by a steam relay, the valve of which is controlled by a solenoid, and the action has been rendered more sensitive, and the economy of the motor at light loads improved by superimposing a reciprocating motion to the position of the relay valve, the action being to eliminate friction and stop hunting as well as to admit the steam in blasts at full pressure, and of longer or shorter duration, according to the work required from the motor. In some cases the solenoid has been replaced by a centrifugal governor of ordinary type.

The advantages of the turbine for driving dynamos and alternators may be summarised as follows:—

1. Smaller first cost of plant.
2. Smaller cost of building and foundations.
3. Smaller cost of upkeep.
4. Reduction of engine-room staff, the machinery being smaller and lighter, and more easily managed and controlled.
5. Ease and rapidity of running up plant.
6. Impossibility of injury of turbines through priming.
7. A total absence of grease in the exhaust steam or condenser.
8. The smaller first cost of plant, especially in the larger sizes, enables more spare plant to be kept ready suitable for the load, and consequently effecting a considerable saving of coal.
9. A small consumption of steam at average load in the larger sizes and abnormally so in the large sizes of the condensing types.
10. Greatly diminished vibrational disturbance to the ground and building, owing to the absence of reciprocating parts.

(*To be continued.*)

* Read May 26th, 1897.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

On Dynamos. By W. M. Mordey, Member. (Paper read May 20th, 1897.)

1. The development of the dynamo has been very rapid. The subject from the first proved attractive to engineers and scientific men, as well as to commercial people. After quantitative methods were introduced, a few years' work sufficed to bring the machine up to a high degree of excellence, as changes were easily made and their effects readily observed. Rapid progress on sound lines was greatly facilitated by the remarkable paper read by Drs. J. and E. Hopkinson in 1886 before the Royal Society. The paper read in 1893 by W. B. Sayers before this Institution indicated possibilities of progress in a new direction. In spite of this suggestive paper, practice appears to have settled on certain regular lines. For some years little or no advance has taken place, and the dynamo has come to be looked upon as having substantially reached its full development—except, perhaps, as to size—present practice and present proportions being regarded as very unlikely to be departed from.

2. Does it deserve its high reputation? As a working machine it certainly does. The results it gives are excellent. It is cool, reliable, durable, highly efficient, has good regulating qualities, and good collection, even in some cases with fixed brushes and varying load. But these excellent qualities, possessed, at any rate, by the best machines, are obtained at a high price, by the lavish use of costly materials—at the cost of a large air gap, of excessive excitation, and magnets larger both in length and section than the armature should require.

If designs which require a lavish expenditure of material to attain a desired result are unsatisfactory, then the best modern dynamos leave plenty of room for improvement. Instead of being regarded as a finished product, they should be considered crude, imperfect, and unsatisfactory.

3. To establish this contention, a statement of one simple fact should suffice. One-tenth of the present exciting power would amply suffice to magnetise the iron of the magnetic system (and a gap sufficient for clearance) to its required value; the other nine-tenths may be looked upon as spent directly or indirectly in overcoming armature reaction.

In attempting to improve dynamos, our aim should be, while retaining a high standard of practical working, to get more work than at present from a given value of material and labour.

4. Output is limited by sparking, by heating, by questions of regulation, and by strength of the working parts. It is better that the limit should be heating rather than sparking, in order that overloading for short periods may be possible. If a machine sparks much when overloaded, then its normal output cannot well be exceeded; but if it does not spark it may be overloaded for a short time, as it only heats slowly. Too much attention can scarcely be given to this subject, for on cool working the life of the machine mainly depends. It is to be feared that attention has often been given to preventing heat losses by aiming at a high efficiency, and not sufficient attention to getting rid of the heat that is generated. This paper deals especially with conditions bearing on the reduction of material and labour by minimising sparking and armature reaction. But it must not be overlooked that, the more we may succeed in reducing these, the more important becomes the question of cooling—of ventilation, radiation, and conduction—in order that we may safely avail ourselves of any possible gain of output.

5. It may be thought that in the present paper references to sparking should be condensed, after the fashion of the famous treatise on Snakes in Iceland, into—"There is no sparking in modern dynamos." But a natural historian, in explaining the absence of snakes, might perhaps have argued that there were incipient or suppressed or potential snakes, and that their outward and visible manifestation was only prevented by equal and opposite snakes, or equivalent devices. So with dynamos. Good dynamos do not spark, or the sparking is negligibly small, or only troublesome under varying loads with fixed brushes. But sparking is kept under by expensive means.

6. A large part of the present waste is surely preventible. That the above estimate of this waste is not excessive may be judged from the consideration of the following imaginary case:—Consider a dynamo designed, so far as the armature is concerned, on ordinary lines, and with a field, in the first place, sufficient to enable full volts to be obtained, but no current; the armature conductors being, however, large enough to carry the full current. Such a machine might have a toothed armature, an air gap only sufficient for clearance,* and a short magnetic circuit. It would require very little excitation. Now attempt to load it—reaction sets in, and to check this the gap is increased; then we must add field winding, add length to the magnet in order to provide space for the increased winding, add section to the field magnet in order to convey the leakage magnetism which results from the increased gap, and so on, cumulatively, till finally we have increased the excitation 30 to 50 times, and made the magnet much larger (in length, in section, and in copper) than when we started. Practically the whole of this increase is a direct result of armature reaction.

7. Let us examine the excitation data of any well-known dynamos. For example, let us take the Edison-Hopkinson dynamo, fully described in the Hopkinson's 1886 Royal Society paper, as an example of a smooth core, and the 150-kilowatt "Railway Generator" of the General Electric Company of America, fully described in the 1896 edition of Prof. Thompson's "Dynamo-electric Machinery,"† as a

* As showing how small an air gap suffices for mechanical purposes, the practice in the case of polyphase motors may be referred to. In these machines large "armature reaction" is essential to their success. The following are the clearances adopted by one maker:—

H.P. of motor.	Clearance in millimetres.
1-24th	0·3
5	0·5
30	0·7
100	1·5
300	2·5

† P. 434, plate xi.

very recent example of a toothed-core machine, based on an extensive experience.

Comparison of Distribution of Excitation.

	"Railway Generator" 150-k.w. (1896). (6 poles.)		Edison-Hopkinson 34-k.w. (1886). (2 poles.)	
	Per cent.		Per cent.	
Air gap	44·39	88·15	80·2	89·8
Teeth	3·06		...	
Compounding	40·70		9·6	
Armature core	0·71		0·68	
Field cores	4·58	11·04	6·61	9·53
Yoke	6·56		2·92	
	100·00		100·00	
Ampere-turns, total	19,630 ..		20,156	

The machines are taken as examples mainly because the full information necessary for the present purpose is available. They are admirable machines.

8. An examination of the table reveals some interesting resemblances. If any part of the magnetic circuit of a dynamo may be considered more essential than any other part, the armature core is probably entitled to that distinction.* In the two cases this essential part absorbs respectively 0·68 and 0·71 per cent. of the excitation; the other 99·3 per cent. is taken up in getting the magnetism through the rest of the circuit.

And when we compare the initial and the full excitation we see that, although the former is small in the toothed machine, the ultimate result in the two cases is about the same; the large reaction in one being balanced by the large air gap in the other. Peter is robbed to pay Paul.

The inference must not be drawn that there is little to be said for the use of teeth in this instance. On the contrary, the teeth have very great practical advantages, even if the excitation were the same in both cases.

The above comparison is, perhaps, a little unfair to the English machine, which was a rather small one, and was brought out 10 years ago. No doubt the designer would improve somewhat on it now, but it is given exactly as published, and serves very well to show that Dr. Hopkinson raised the dynamo in 1886 to so high a level that subsequent improvement has been comparatively slight, and very difficult; and it must not be forgotten that he started from chaos.

"THE MAGNETISING SPACE."

Before proceeding further, attention is drawn to the subject of diagrams.

9. The consideration of excitation and armature reaction is simplified by clear diagrams. Instead of showing helical windings disposed about the field magnet, it seems better to show merely a flux of current through a space bounded by the armature core, the pole-tips, and the part of the magnet joining the pole-tips. This space may conveniently be termed "the magnetising space;" it is shown in several of the figures used for the illustration of this paper. Bearing in mind that the primary object is, or should be, to magnetise the armature, the diagram shows clearly the essentials of the magnetic circuit. The winding is shown in section by circles which are respectively black or dotted, to indicate the two directions of the current. Clearly it is not necessary, so far as the direct influence on the armature is concerned, to show the completion of the field turns; they may be completed by going round the armature, or round any part of the field, or, for the matter of that, they need not be completed at all so far as the armature cares. This kind of diagram reduces all forms of field magnet to a common basis, and illustrates the essentials of the magnetic circuit. And it helps to the understanding of the problem of self-exciting armatures by showing how the armature conductors supply the "magnetising space" with current, in the magnetising direction or the reverse.

10. In earlier days we often debated the weighty question, What part of a dynamo or motor should be the heavier? We are now probably all too wise to spend time in such discussions. Our point of view has altered, and we wish only to make each part as light, or, at least, as inexpensive, as we can. A simple diagram of this sort helps to the appreciation of what seems to be the true function of the field magnet. A field magnet should be a mass of iron so arranged as to complete the magnetic circuit between one side of the armature and the other, in the shortest possible distance, and with as small a cross section as is consistent with the economical conveying of the magnetism of the armature.

Field magnets seldom accord very closely with this definition.

COMPARISON OF TYPES.

11. Of the two classes† of dynamos—smooth-cored and toothed—the former is preferred in this country, principally because the collection is so good; the latter is preferred on the Continent and in America. In the United States the 500-volt railway generators are almost always toothed; but for low tension lighting work, where large currents have to be collected, smooth cores are often used.

In comparing the two types, we may say of the smooth-cored type that in practical work it gives excellent results; that its collection is excellent, but that it is expensive in material, and in some other respects unsatisfactory.

12. The toothed kind does not collect well, and is not a good regulator, but it has so many good qualities that it is of the greatest importance to remove what is objectionable in it. What may be termed its latent advantages—mechanical, electrical and magnetic, as compared with the smooth-core type, are:—

1. Small excitation.
2. Small magnetic leakage.
3. Absence of eddies in armature conductors.
4. Armature conductors solid instead of laminated.
5. Drag on armature conductors small.
6. Armature conductors easily supported.
7. Cooling qualities very good.
8. It is cheaper to make.

13. These are termed latent advantages, because they are not at present all realised. Referring to the various points:—

(1) *Small Excitation.*—The excitation is usually smaller than in smooth-cored machines, but not nearly so small as it might be made. The reasons are, that to check armature reaction and to keep sparking within limits, the gap is usually made a good deal larger than would suffice for mechanical clearance, and the teethed are often worked at a very high density, giving the effect of a still larger gap.

(2) *Magnetic Leakage.*—As leakage depends principally on the difference of magnetic potential across the gap, it follows from (1) that it is larger than it ought to be. Some general observations on this matter will be found in another section of this paper.

(3) and (4).—*Absence of Eddies in Armature Conductors.**—This advantage is fairly realised. Except when the teeth are saturated there is very little magnetism in the slots, and the conductors need not be laminated. This saves power, reduces cost, and makes the conductors more mechanical and easier to wind.

(5) and (6). *Drag on Armature Conductors.*—As this is practically absent, the conductors require only sufficient support to drive them, without reference to the load. Even if this were not true (and the question is considered in another part of the paper), the mechanical support afforded by the teeth would offer a very great advantage.

(7) *Cooling.*—This is very important. In a smooth-cored armature the core is covered by insulating materials, which, unfortunately, insulate heat nearly as well as electricity. In a toothed armature, the exposure of the bare metal surface assists very materially in getting rid of the heat. The value of this feature can hardly be overstated.

(8) *Cheapness.*—The toothed type for any given output is, even now, cheaper than the smooth-cored.

14. If the above statements are correct, the toothed type has everything in its favour except sparking and armature reaction. Advocates of smooth-core construction may assert that the drawbacks to their favourite type are more apparent than real—that when once set in the bearings the armature gives no trouble. But this is no answer to the really inherent objections to the type, and we all know that in building and handling it requires much more care and skill than the toothed kind.

15. And, on the other hand, advocates of toothed armatures may say that it is rather late in the day to insist on the advantages of the machines they have been building and using for years; that the machines are excellent, do not spark at all, and so on. All which may be quite true. Some of the machines are excellent. But there are two extremes (and a great many intermediate varieties) in the class of toothed-armature dynamos:—

1. Those with a small gap reluctance and bad collection; and
2. Those with a large gap reluctance and a better collection.

In neither sort are the full potential advantages of the type realised. The large gap variety ought, perhaps, to be considered intermediate between the smooth-cored and the toothed kinds. The teeth support and drive the conductors, but the excitation is not small, and the armature reaction is very great in spite of the gap (as is seen by the comparison quoted above); and to the extent that the magnetism is not carried by the teeth, so are the full benefits and economies of the toothed type lost: the direct drag is felt by the conductors; they have eddies generated in them, and if they are large, require to be laminated; the magnetic leakage is considerable, and the machines are not very cheap to build.

MAGNETIC LEAKAGE.

16. Magnetic leakage is a much more serious evil than is generally admitted. In most dynamos it is enormous, even in machines which enjoy the reputation of being nearly perfect examples of design, and which, indeed, are nearly perfect, judged by present standards. For example, the ordinary two-pole drum dynamo only utilises about 70 per cent. of the magnetism produced. The leakage coefficient (v) given in the Royal Society paper already referred to was 1·32, which

* The armature will work when surrounded by an existing coil, even if the whole of the field magnet iron is removed.

† Dynamos with "coreless" armatures are not important enough to form a class. The reasons which led to the use of "coreless" alternators do not apply to dynamos: in the latter the periodicity is not high enough to justify the omission of the iron.

* An experiment made some years ago by the author may be referred to as illustrating the absence of eddies in conductors surrounded by iron. A transformer of the closed magnetic circuit type was wound with one winding only, the space usually occupied by the second winding being left empty. The winding was connected to a suitable source of alternating E.M.F., and the power absorbed was measured by a very sensitive wattmeter readily capable of showing a small increase in the excitation. Solid bars of copper were then inserted in the vacant space. There was no increase in the excitation. If any eddies had been set up they would have acted as a load, and the wattmeter would have shown the amount. The object of the experiment was to ascertain whether it was necessary to laminate large secondary conductors in transformers; in closed-circuit transformers it was not necessary. This case is perhaps not on all-fours with sunk windings, but they are closely related.]

means that out of every 132 lines of force produced in the field magnet, only 100 pass through the armature, the other 32 leak past the armature and are wasted. This coefficient was obtained from an unloaded machine. At full load v would probably be 1·4 or more. Values of v for six varieties of machines given by Prof. Thompson* range from 1·25 to 1·49—average, 1·34.† The proportions of all dynamos have to be seriously modified to allow for this waste. The section of the magnet is increased from 20 to 30 per cent., or if not increased in section, it must be increased in length to carry the greatly increased field winding. The incidental disadvantages connected with leakage of magnetism are well known—disturbance of compasses on board ship and of watches, the use of non-magnetic distance pieces, and so forth—and there is no incidental advantage of any sort. It is sheer waste.

17. The magnetic system of a dynamo is usually considered from what appears to be a misleading point of view. It seems to be a mistake to begin by magnetising the field magnet when the real object is to get the armature magnetised. It may be answered to this, that there is no beginning—that the whole magnetic circuit has to be magnetised, that the armature is only one part—and a very small part—of it, and that it comes to the same thing, however, or wherever we magnetise the circuit. But there is a difference, as was recognised long ago by Forbes,‡ and realised by Eickemeyer, who placed the exciting coil directly round the armature, where its effect was primarily wanted, instead of round the field core.

The full significance of this construction has perhaps not been generally recognised. Its effect on magnetic leakage is very important, for it makes the leakage negative. In other words, as the armature carries more magnetism than the field, instead of less, the leakage becomes a friend instead of a foe; for practically all the magnetism generated is now useful, because it traverses the armature.§ It is, of course, not to be inferred from this that the leakage should be encouraged by skimping the iron.

18. The practical objection to this construction is that it is not so simple to dispose the field winding round the ends of the armature as round the core of the field magnet, and that there is no gain in copper or energy, as the length of the turn round the armature is usually more than round the field. But the absence of external stray field and shortness of the magnetic circuit are points of much practical importance, worth some effort to obtain. The inconvenience of inside windings will become less as we learn how to reduce their amount. And what would help materially would be the reduction of the cost, and the improvement of the quality, of steel castings. This country is behind others in this important trade, and it behoves our steel founders to give it their attention. Magnetic steel castings are being produced in the United States in large quantities, with ribs and other thin parts clean and thin as if of cast-iron.

19. The considerations affecting leakage, as connected with the disposition of the field magnet, become of diminishing importance as the air gap is reduced. If there were no gap there would practically be no leakage—a further reason for using toothed armatures.

20. What we want is the sparkless collection and small armature reaction associated with smooth cores, together with the advantages of economy and of energy which are inherent in toothed armatures, but which are at present not fully realised in practice.

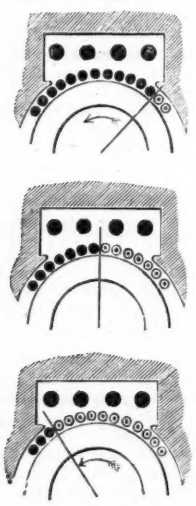


Fig. 1.

21. It is a very singular thing that the windings originally introduced have continued in use practically without change ever since. For instance, in ring armatures, the ordinary endless helix, coiled round an iron core, with connections taken at regular intervals to a collector, is in use to-day just as it was introduced by Gramme and Pacinotti about 27 years ago.

22. With this, as with all ordinary windings, we have the conditions of things shown in the three diagrams in fig. 1. With no lead, the positive and negative directions balance. With brushes lagging to the backward pole-tip the armature current helps the field; with brushes leading to the forward tip it opposes the field—the usual collecting position necessary to secure good collection. There are other well-known aspects of armatures, but they do not come within the scope of this paper. We should use some arrangement such that, without loss of E.M.F., the armature conductors in the "magnetising space" shall produce no weakening of the magnetising force, or, preferably, shall add to the magnetising force in that space. If we can collect with a lagging brush,* the armature current will help the field winding. Or if we can collect in a midway position, the armature currents will be equal and opposite, and there will be little or no counteracting effect. The two latter conditions are ordinarily prevented by sparking, as the coils under commutation have an active E.M.F. in them, and a large current is generated in the short circuit.

(To be continued.)

* "Dynamo-electric Machinery" (1896, p. 151).

† All light load values; for full load they should be considerably increased.

‡ British Patent 4,120, 1885.

§ That the leakage may be useful, instead of detrimental, is evident from the fact that an armature will work if surrounded only by an exciting coil, the iron of the magnet being removed. In such a case all the magnetism would be "leakage."

ON THE MAGNETISATION LIMIT OF IRON.†

By HENRY WILDE, F.R.S.

In my paper "On the Influence of Temperature upon the Magnetisation of Iron," I described a new method of determining the magnetisation limit of magnetic substances, by which, with a single pole of an electro-magnet, a more exalted degree of magnetisation was indicated, as measured by the force of traction, than had previously been attained.‡

The magnetisation limit of iron, as deduced from my experiments, was 381 lbs. per square inch of section, and it appeared to me at the time that the extreme limit was well within 400 lbs. per square inch.

I have recently had occasion to repeat these experiments with other specimens of iron of different lengths, and have increased the magnetisation limit sufficiently high to place the result on record.

Definite lengths of annealed charcoal-iron wire of circular section, 0·57 inch diameter, as measured by a micrometer screw gauge, were cut from the same piece of wire, and mounted for suspension over the electro-magnet in the manner described in my former paper.

The specimens of iron were submitted in succession to the action of the electro-magnet excited by a current of 40 amperes, and the force of traction was measured by the weight required to detach the iron wires from the magnet, with the followihg results:—

Number of experiment.	Length of iron wire.	Tractive force with current = 40 amperes.	Tractive force per square inch.
	inch.	lbs.	lbs.
1	0·2	0·984	385
2	0·4	1·016	397
3	0·6	1·059	414
4	0·8	1·074	420
5	1·0	1·078	422
6	1·2	1·078	422

It will be seen from this table that the magnetisation of the first specimen agrees well with the result of my former experiment with similar charcoal-iron wire of the same length and 0·05 inch diameter, the tractive force being proportional to the sectional areas of the wires respectively. It will also be observed that the tractive force increases with the length of the wire up to 1·0 inch, beyond which no higher degree of magnetisation was obtained.

That the magnetisation limit (422 lbs. per sq. inch, or 29·67 kilos. per sq. cm.) was virtually arrived at in these experiments was shown from the fact that, when the current transmitted round, the electro-magnet was reduced from 40 to 26 amperes, the amount of the tractive force remained constant.

That the single-pole method of determining the magnetisation limit of magnetic substances compares favourably with the double-pole method was proved by the following experiment:—

The electro-magnet employed in the previous experiments consisted of a single limb of the large magnet used in my demonstration of the indefinite increase of the magnetic and electric forces from quantities indefinitely small§ The second limb of this magnet was replaced, and both limbs were furnished with flat tapering poles having a space of 0·3 inch between them.

A piece of the same wire used in the previous experiments, 1·2 inch long, was bent into a U-form, with the inside of the limbs 0·3 inch apart, and carefully balanced over the tapered poles. It has been shown that the same length of wire in the straight form required a weight of 1·078 lbs. to detach it from the electro-magnet.

* The expressions "forward lead" and "backward lead," although sanctioned by misuse, are not happy ones. "Positive lead" and "negative lead" are better. "Lead" and "lag" are shorter terms.

† Royal Society. Received April 3rd, read May 13th, 1897.

‡ Roy. Soc. *Proc.*, 1891, Vol. 50.

§ Roy. Soc. *Proc.*, April, 1866. *Phil. Trans.*, 1867.

It might, therefore, have been expected that the U-formed iron wire would have indicated at least double this amount, or 2·156 lbs., whereas the tractive force obtained was only 1·625 lbs. Some of the diminished magnetic effect was no doubt caused by the inductive action of the tapered poles upon each other, and also through the mechanical force of separation not being applied so directly as in the experiments with the straight iron wires. Enough, however, has been shown to prove that no higher degree of tractive force is to be expected from the double-pole method of determining the magnetisation limit of magnetic substances than has been obtained by the single-pole method.

THE LIMITATIONS OF GOVERNMENT IN WATER-POWER PLANTS.

By MARK A. REPLOGLE.

THE regulation of the speed of a water-wheel in a power plant is determined by four distinct factors:—

1. Changes in load or requirements for power.
2. Time required for gravity to generate power.
3. Capacity of the plant for stored energy; and
4. The governor or mechanism that should automatically combine the above three factors in such a manner as to obtain even speed or good regulation. These factors, clearly defined, are bases from which intelligent calculations can be made showing the possible efficiency of government in any water-power plant.

Let it be understood that the word "government" refers to that regularity of motion or speed that is so desirable and necessary in our finest manufacturing and electrical power plants. Absolutely uniform speed can be maintained only when there is no change in the power supply and no change in the friction or work of the plant; but if the above factors are carefully considered and judiciously manipulated or applied, the variations of speed may be so reduced that the results can be called perfect government.

The speed of a plant at all times is a resultant of opposing forces establishing an equilibrium or balance. The power supply has a tendency to increase speed and the work has a tendency to decrease it. Speed may be varied by increasing the power supply or by decreasing the power supply; by increasing the amount of work performed, or by decreasing the amount of work performed; and any one of the above changes causes instantly a change in the speed; but the amount of change in speed depends entirely upon the amount of change in load, the time it takes gravity to generate power, the quantity of energy in store, and the operation of the governor in opening or closing gate.

Since it is impossible for any automatic governor to change the power supply at the instant a change has been made in the load or work of a power plant, it is very plain that there must be fluctuations in the speed. The problem of government is to narrow these fluctuations to such an extent that the speed will be constant as far as practical operation is concerned. The finest government ever obtained consisted of changes in speed, but within narrow limits. The speed of a well governed single-crank engine changes four times every revolution.

The first factor in governing "the changes in load" is a variable one, and is limited only by the character of the work done by the water-wheel. The changes may range from zero to the full power of the wheel instantly, making government a more difficult problem than it would be if the changes were limited in number or quantity. It is plain that if an even speed is retained when a change in load is made, there must be at the same instant a corresponding change in the power supply. This is an impossibility in automatic governing for several reasons; the speed must change in order to inspire the speed governor; following this the speed governor causes the valve or gate-moving mechanism to operate, which operation requires time, and, again, it requires time for gravity to overcome the inertia of the increased quantity of water that must pass through the wheel before an increase in power can be had. During all this time, the speed of plant has been decreasing if the load was increased, or increasing if the load was decreased, and the amount of change in speed depends entirely upon what ratio the change in load bears to the stored energy in the moving parts of the plant. A heavy change in load will of course cause a greater change in speed before the power supply is changed, than a light change in load. The problem is, therefore, to proportion properly the power storage to the changes of load that must be imposed upon the plant, because this power storage, or the capacity to store power, must take care of all changes in load until the power supply, or gravity effects, can compensate for said changes.

The second factor, "time required for gravity to generate power," is more constant than the first. In fact, the limits are established in the construction of the water-power plant, and, of course, remain so. The point we wish to emphasise most in the time requirements is the inertia and momentum effects of the water.

A locomotive can propel a train of cars at a rapid speed; but it takes time to acquire such speed. When the locomotive has brought enough pressure to bear upon the train it moves, at first slowly, but keeps increasing in speed often many seconds before it reaches full motion. The locomotive may be limited in strength to 250 H.P. per second. The train in full motion may represent 25,000 H.P. for a second. In such case, it will take the locomotive 100 seconds to bring the train to speed if we do not consider the frictional losses. Water has no power in itself; but must be put in motion by gravity in the same manner that the locomotive starts the train of cars, and a long train of water acted upon by a constant gravity effect, is put in motion in the same manner that the train of cars is by the locomotive. It is plain, then, that the time element must be considered in the government of water-power. The water-wheel cannot furnish power until it brings to rest the water to which gravity has given motion, and it can receive no power from the water until the water has sufficient motion for the moving wheel to retard. It is also plain that there must be changes in the flow and velocity of water for every change made in the load of the water-wheel; also the change in the flow of water must occur before there can be a change in the power supply.

It is well known that water has practically no elasticity; hence, if enclosed in a long pipe, the whole body must be put in motion at the same time. If the pipe or flume consists of several hundred feet of horizontal length and only a few feet of vertical pipe or "head," which alone gives gravity effects on the wheel, it is a similar proposition to the locomotive and train of cars. It is very evident, then, that long horizontal pipes should be avoided in order to reduce to a minimum the time required to get gravity effects, because the speed of water-wheels will keep changing, after a change in load, until the effects from gravity can correct it in the power supply.

Gravity effects at best are very slow as compared with steam, and for this reason a water-power is handicapped in the matter of government. The logical conclusion is, that in water powers the water or power supply should all be under the direct action of gravity and move in line with it. This reduces the time necessary to furnish increased or decreased power, to the shortest limit.

THE HOLLAND SUBMARINE TORPEDO BOATS.*

By ROBERT McA. LLOYD.

THERE has been so much said in the newspapers during the last year about the two Holland submarine torpedo boats being built at the Columbian Iron Works, Baltimore, Md., and the Crescent Ship Yard, Elizabethport, N.J., and so little actually done with the boats, that the public have very little faith in the promises of the apostles of this kind of navigation. The boat at Baltimore has been two years in process of construction, under Government supervision, and may be finished during the coming summer; the one at Elizabethport was contracted for in November of last year (1896) and has been rapidly completed, so that within a few weeks it will be ready for trial, having been launched on Monday.

The Baltimore boat is much the larger, and more powerful, but since it will not be finished for some time, I shall refer to it very briefly. It is 85 feet long and 168 tons displacement. On the surface it will be propelled with 1,500 horse-power of steam engines, and under water by an electric motor of 70 horse-power, getting its current from a storage battery which has a six hour capacity at that rate. This boat has a heavy armour turret and a great quantity of machinery, and is armed with two torpedo tubes in the bow.

The Elizabethport boat has the advantage of greater simplicity both as to construction of the hull, and equipment of machinery, and will have some features of importance in the way of armament not included in the other. It is 53 feet long with a displacement of 74 tons and a diameter of 10½ feet. It is propelled by a single screw, and has for power a large gas engine, and an electric motor with a storage battery that will deliver 150 horse-power for one hour, driving the boat at 14 knots submerged or 50 horse-power for 6 hours, giving a speed of 8 knots submerged. The speed in surface running will not be so great for the same power. The boat has a small telescopic turret for observation and effective devices for handling under water. She has a single 18-inch torpedo expulsion tube in her bow, an aerial dynamite gun forward, and a submarine dynamite gun aft. She will be able to dive and run at any depth below the surface down to 100 feet, and can be instantly adjusted to maintain any fixed depth while running. If running under a fleet in deep water, she would, of course, need at least 30 feet of clear depth over her, but when attacking a ship might take a higher level so as to be able to come quickly to the surface now and then for an observation. She has a powerful hull and could stand the pressure at 150 feet if necessary, but for fighting purposes would never be required to go to a great depth.

The many details for ventilating, trimming, diving, steering, and propelling cannot be described here, but inasmuch as electricity plays such an important part in these operations, electrical engineers may well consider the launching of this boat an event in the history of electrical development. Submarine boats have been built and tried many times in the past two centuries, and of late years have received considerable scientific treatment, but nothing of practical value has been accomplished until recently, when the electric motor and storage battery have made the problem easier to solve. The history of Mr. John P. Holland's tireless efforts with the Government, and with capitalists, to put the submarine boat business and submarine warfare on a practical basis would make interesting reading, but a point has now been reached when it is not too much to predict that naval warfare is about to be revolutionised, and electricity is to find a new and large field. If the boat to be tested next month is a success at all, our Government will order a large number of them this year and may possibly use hundreds of them, which, of course, means a large quantity of electrical apparatus.

Then there is a large field for their use in wrecking operations and in harbour surveying, in submarine exploration, mining, building, &c., and in all these boats the propulsion, lighting, pumping and other mechanical offices will be performed by electricity. There may be

* New York *Electrical Engineer*..

also large submarine battleships: but it seems probable that nothing could be accomplished by them that would not be within the capabilities of a 100-foot boat.

In the serious business of war the submarine torpedo boat has such a manifest advantage, that the only question ever raised is, can you build one? A few more weeks will apparently settle this question in the affirmative, and the indications are that with every Government in the world armed with submarine ships within the next 10 years, naval warfare will become very unpopular.

In the fascinating pursuit of lost treasure, and the exploration of submarine property, the submarine boat will doubtless become a great aid to the wrecker and diver, and make possible the lifting of ships that otherwise could not be reached, and add much to our knowledge of the sea. Most of the wrecks that are going down every day, lie less than 250 feet from the surface—not too great a depth for submarine boats—and with their aid in sweeping chains and fastening them to pontoons, a much larger proportion will be recovered than in the past.

To enumerate further the possibilities now awaiting fulfilment seems to be taking up space which should be devoted to the technical details of this subject, but the machinery is so simple that it does not compare in interest with the boat as a whole, or its mission. Dynamos, motors, storage batteries, air compressors, gas engine, ventilating pump, bilge pump, steering engines, gauges, valve controllers; nothing worth writing about half so much as a single dive will be in the waters of New York Bay a few weeks hence.

NEW PATENTS.

Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

12,126. "Improvements in arc lamps." W. N. Stewart, F. Beanland, and J. W. Perkin. Dated May 17th.

12,128. "Improvements in apparatus for working railway points and signals by electric power." F. W. Webb and A. M. Thompson. Dated May 17th.

12,134. "Improvements in the hanging of electroliers and other electrical fittings." Dated May 17th. (*Complete.*)

12,204. "A new or improved method of re-transmitting telegraphic messages, and apparatus for use in connection with the said method, and for other purposes." J. Rymer-Jones. Dated May 17th.

12,210. "Improved electrical traction apparatus." R. Demeuse. Dated May 17th. (*Complete.*)

12,211. "Improvements relating to electric traction." F. F. M. A. Nave. (Date applied for under Patents, &c., Act, 1883, Section 103, 17th November, 1896, being date of application in France.) Dated May 17th. (*Complete.*)

12,237. "Automatic electric signal for railways." G. F. Gascoyne. Dated May 18th.

12,251. "Improvements in electric indicators." F. Jones. Dated May 18th.

12,327. "A new or improved device for use in connection with storage batteries." G. Walter. Dated May 18th. (*Complete.*)

12,329. "A new or improved arc enclosing device for electric arc lamps." S. E. Fedden, J. W. Prior, and R. Middlemass. Dated May 18th.

12,336. "Improvement in electric arc lights." D. A. Shesler. Dated May 18th.

12,383. "Automatic fuse replacer for cut-outs." F. J. Borland. Dated May 19th.

12,435. "Improvements in electric conducting cords and means for connecting them to walls and other supports." M. K. Perci and F. Schacherer. Dated May 19th.

12,443. "Improvements in electric accumulators." A. Werner and P. de. Kilduchevsky. Dated May 20th.

12,455. "Improvements in and relating to prepayment devices for use with telephones." S. Silberberg. Dated May 20th. (*Complete.*)

12,469. "An improved method of arranging the coils of a set of electrical resistances and means for manipulating the same." J. H. Reeves. Dated May 20th.

12,473. "The electro-magnetic propulsion machine." W. T. Pember. Dated May 20th.

12,530. "Improvements in dynamo-electric machines." W. M. Mordey. Dated May 20th.

12,531. "Improvements in electric switches." G. W. Partridge. Dated May 20th.

12,542. "Improved spring clip for holding papers or other articles applicable for telephone boxes or other instruments." F. Hilton and J. E. Howarth. Dated May 20th.

12,544. "Improvements in the process and apparatus for the electrolysis of alkaline solutions and the like." H. P. M. Brunel. Dated May 20th.

12,549. "Improvements in plates for accumulators." W. Majert. Dated May 20th. (*Complete.*)

12,589. "Improvements in automatic circuit closing devices for galvanic batteries." J. D. Holmes and W. L. Heath. Dated May 21st.

12,639. "Improvements in means for regulating the voltage of dynamos." La Societe Generale des Industries Economiques. (Date applied for under Patents, &c., Act, 1883, Sec. 103, March 20th, 1897, being date of application in France.) Dated May 21st. (*Complete.*)

12,642. "Improvements in contact fingers for electric controllers." E. C. Parham. (Date applied for under Patents, &c., Act, 1883, Sec. 103, November 18th, 1896, being date of application in United States.) Dated May 21st. (*Complete.*)

12,643. "An improved system of conductors for electric railways." E. Lachmann. Dated May 21st. (*Complete.*)

12,675. "Improvements in galvanic batteries." R. Krayn and C. Koenig. Dated May 22nd. (*Complete.*)

12,692. "Automatic steering apparatus for toy or other sailing, steam, electric, and other motor-driven boats." E. J. Mackenzie. Dated May 22nd.

12,714. "An improved insulating and carrying frame for accumulator electrodes." F. W. Schneider. Dated May 22nd. (*Complete.*)

12,721. "Improvements in the construction and regulation of arc lamps." H. Leitner. Dated May 22nd.

ELECTRICAL PATENTS OF 1883 EXPIRING IN JUNE, 1897.

We are informed by Messrs. W. P. Thompson & Co. that about 65 applications for electrical patents were filed in the month of June, 1883. Out of these applications those that were completed only three have been allowed to run their full length of term (viz., 14 years), and being of considerable interest we give short abstracts of them below.

2,832. "Improvements in apparatus for connecting and disconnecting electrical circuits, and limiting and measuring currents passing through them." H. H. Cunynghame, O. E. Woodhouse, and F. L. Rawson. Dated June 7th, 1883. In an automatic closing apparatus, the armature of an electro-magnet can pass to either side of the pole of the magnet, being strained by a tumbling weight. In one attitude it closes the circuit; in passing to the other attitude it opens the circuit. When the strain of the tumbling weight is overcome by the electro-magnet the contact is broken. When operating as a safety plug, an electro-magnet with a movable iron core in combination with a torsion spring and an index limits the strength of the passing current. For connecting the circuit wires, the contact screws have a longitudinal or oblique notch in a screw bolt; into this notch is inserted the wire. A nut is screwed down upon the wire and holds it firmly in the notch. 3 claims.

3,115. "Improvements in dynamo-electric machines." G. Forbes Dated June 22nd, 1883. The armature is a revolving mass of iron without coils. The field-magnet is continuous all round the armature, which it completely encloses, except that there is a central by which the axis passes. The magnet presents a continuous north pole to one side and a continuous south pole to the other side of the armature whose polarity is also continuous. The armature may be a disc mounted upon an axis and confined within a soft iron box. The periphery of the disc is surrounded by a conducting ring by means of which the current is drawn off. Good contact is ensured with this conductor by means of mercury which is retained in its place by centrifugal force. The axis of the disc conveys the current from its centre, the second terminal is a brush. The apparatus may be duplicated, two armatures being on the same axis. In this case the winding of the magnets is so arranged that two conducting rings surrounding the armatures may serve the one as the positive the other as the negative of the machine. 5 claims.

3,116. "Improvements in the arrangement of circuits and apparatus to be used in connection with telephonic communication." S. Pitt. (C. E. Scribner, United States.) Dated June 22nd, 1883. Describes an arrangement of circuits and apparatus for use in what is known as the central office system. Testing apparatus for multiple switchboards to ascertain whether line is at use at any other board, the lines are each connected with a single switch on each of the multiple boards, the frames of the switches on each line being connected together by a wire. The testing apparatus consists of an open ground circuit containing a battery and bell relay or telephone and a connecting piece for applying to the switch frames. If the line wanted is in use at another board the battery will be closed to line when the connecting piece is applied to the switch frame and the bell will be rung. Describes various modifications of the testing apparatus, also an automatic system of circuits for connecting the switches of two subscribers together, also for a system of circuit between central office and subscribers stations. Refers to specification No. 4,903 of 1879. This specification was amended by decision of the Comptroller-General on July 10th, 1893. 9 claims.